NEW CENTURY PHYSIOLOGIES

INTERMEDIATE PHYSIOLOGY

NEW CENTURY SERIES

OF

ANATOMY PHYSIOLOGY AND HYGIENE

BY

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FOR

LOWER GRAMMAR GRADES

BY

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INDORSEMENT

We, the undersigned, have carefully examined the school text-book entitled

INTERMEDIATE PHYSIOLOGY AND HYGIENE,

by Professor Winfield S. Hall, M.D., and Jeannette Winter Hall, with reference to the following points:

1. Fullness and accuracy of subject-matter relating to the nature and effects of alcoholic drinks and other narcotics upon the human system.

2. Amount of matter on general hygiene.

3. Presentation of matter with regard to its adaptability to the class of students for which it is designed.

We are satisfied that on all of these points, as well as in the regular anatomy and physiology, the treatment is as complete as is required for a book of this grade, and fully in harmony with the results of the latest investigations. We therefore heartily indorse the book for Lower Grammar Grades, or for corresponding classes in ungraded schools.

A. H. Plumb, D.D.
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World's and National Superintendent of Scientific Temperance Instruction of the Woman's Christian Temperance Union.

PREFACE

MAN is a part of the great harmonious and united realm of nature. The study of the human body is therefore a legitimate part of the nature study of the schools.

The method which has met the universal approval of all true teachers in nature study is for the pupil to observe directly and with his own senses the objects to be studied. In harmony with this fundamental principle of pedagogy the authors of this book have endeavored to use every opportunity to make the human body the object of direct study by the pupil. Through this method the pupil becomes interested in his body and its care.

Especial attention is called to the various comparisons between the human body and the bodies of the lower animals. The object of this comparative study is to impress upon the mind of the pupil the unity of nature, and to cultivate in him a love and sympathy for the lower animals.

When physiology is seen to be an integral part of nature study work and of the biology of our educational system, it will not fail to be one of the most interesting studies of the whole curriculum.

WINFIELD S. HALL.
JEANNETTE W. HALL.

CHICAGO, ILL.

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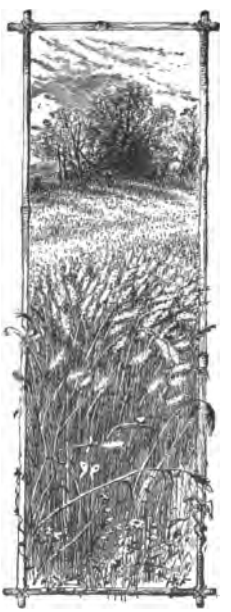
PHYSIOLOGY

THE NEEDS OF A TOWN

If you were to go some summer day to a certain mountain town in Pennsylvania, and, climbing one of the hills close by the town, were to sit down and look about you, you would see how much work and thought and planning it takes to care for the people of one little town.



Away off to the east beyond the town are the fields of ripe grain which the farmers are busy cutting; on the road which winds down into the town are many, many teams bringing the grain to the mill. The mill is that tall building from which you see the wagons carrying the loads of flour.

Far off to the north are the busy coal mines.

You cannot look into them from your place on the hill, but you can see the cars loaded with coal coming into the town, and the boats, too, on the canal, bringing coal to run the machinery of the factories, and to furnish fuel for the houses.

IN A COAL MINE.

On the hill to the left is the great steam pump that sends water to every part of the town. Perhaps you can see the first very large pipe, but the others are underground and out of sight. From this large pipe the water flows into smaller pipes, and these branch off into still smaller ones until

at last they enter the houses through the smallest pipes. There the water is used and is sent out again in little pipes which empty into larger ones and still larger ones until it is carried off by the largest pipe, or main sewer.

See the policemen and the watchmen walking back and forth, guarding the people and all that belongs to them, to keep all safe from harm! Do you see that large building near the center of the town? That is the central telephone station. See how many wires pass out from this building and go out in every direction all over the town.

If you could only listen a little while to what is being said over those wires, you would hear the miller asking the farmer about the grain, and the baker asking the miller to send the flour, and the women in the houses asking to have the bread sent to them. You would hear the policemen sending word about danger at the bridge or at the mines; you would hear people asking for more coal and for different kinds of food. You would

hear still others directing where the coal shall be taken and what shall be done with the grain and other foods.

THE NEEDS OF A TOWN (*continued*)

If you watch all this life and motion, and see what it all means, you will surely say: "How

many things it takes to look after all the needs of a town!" — the miner and the farmer to provide fuel to keep the people warm and grow food

for their bodies; the miller to grind the grain into flour; the baker to put the food into form to be used; the many wagons, cars, and boats to carry the fuel and food from the place where they are prepared to the place where they are used; the pump and one set of pipes to send the water wherever it is needed, and another set of pipes to carry away the waste; the guards to keep the people safe; the telephone system which lets each worker know what the other workers are doing and keeps all things working together.

If you are surprised to see how much is needed to supply a town full of people, you will be more surprised to know that each person has within himself needs similar to all of those that we have found in a town. Each person has within himself means for satisfying all of these needs.

As we study the body we shall find it very much like a town, and that it has what corresponds to a mill, a place to prepare food; what corresponds to wagons and carts, in which food and fuel are carried about; pipes in which liquid is carried over the body; and other pipes in which the waste is taken up and either made clean and used over again or carried away. It has what

corresponds to a telephone system, by which each part of the body knows what the other parts are doing, and even policemen and watchmen to warn of danger and to keep everything safe.

WHY WE EAT

HAVE you ever thought how much time is spent in growing, preparing, selling, buying, cooking, serving, and eating food? I have even known little girls who had to wash dishes, and boys who had to bring in fuel for the cooking, to wish that we did not have to eat; but they never seem to wish that just before dinner. Let us see why we spend so much time in this way.

If the legs or arms of the chairs had to be made longer, the carpenter would have to add a piece of wood to each. When a child's arms and legs become longer and longer each year, we know that something must have been added. That something was the food which the child ate, and unless some food is added there could be no growing. Even if we are not growing, we still need some food.

If boys or girls climb trees or fences, their

clothes usually need mending, and new thread must be woven in and out or new cloth must be

put on. Now, the body that does the climbing wears out, too, and must be mended, not with cloth or with thread, but with food. There is no other

way to mend the body which wears out a little with every motion we make, with every thought we have, and even with our breathing.

Your mother and father, who are now more than five feet tall, were once smaller than you are now, and it is the food which they have eaten which has made them so much larger than they were.

Put your hand on the window glass and see how cold it feels. That is because your hand is warmer than the glass. If there is no fire in the house it feels cold, and so would your body feel cold if there were nothing within to keep it warm. To keep the body warm is another part of the work which the food does. Now we see why so much of our time must be given to getting, preparing, and eating food, without which we could not keep warm, could not grow, could not even live.

We eat to grow, to repair our bodies, and to keep them warm.

WHAT WE EAT: FOODS

As there are many kinds of food and some are much better than others, we ought to know

something of the different kinds and what they are best for.

NATURE'S FOOD: MILK AND EGGS

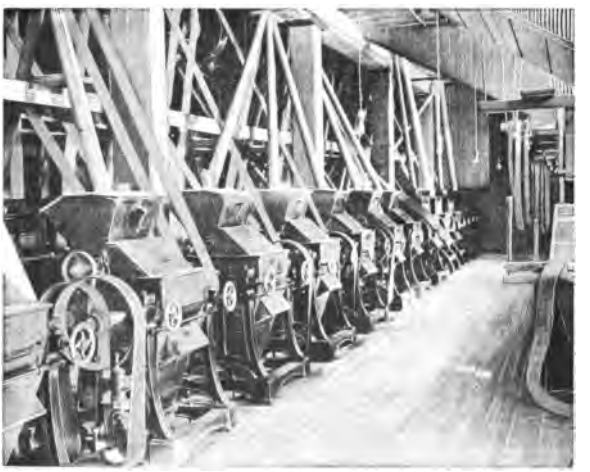
Nature has given us two foods that contain almost everything that we need for repairing the

MILKING TIME.

body, for growth and for heat. These are milk and eggs, which may be taken often by children, yes, and by grown people as well. The eggs do much more good when they are boiled soft, or when cooked with milk in custards or omelets, for when boiled hard, or fried, the stomach has hard work to digest them.

CEREAL FOODS

The grain which the farmer grows is made into white flour, graham flour, or whole wheat flour, or into oatmeal, or corn meal, and cereal breakfast foods of all kinds, and also cereal coffee. All



GRINDING CEREALS.

of these grain foods, excepting white flour, are good to make bones and teeth, and all of them give heat to the body; if too much cereal food is eaten the body lays on fat. If you want your teeth to be hard and firm and your bones to be strong and hard, do not say you will not eat

cereal foods and graham or whole wheat bread, for they, with milk, give the lime which keeps the bones and teeth from being soft and weak.

Hot bread and biscuit, when made of white flour, are not easy for the stomach to digest. Breakfast muffins and cakes, when made of whole wheat flour, of graham flour, or of corn meal, are not hard for the stomach to digest, and may be eaten safely.

MEAT

Meat, especially lean meat, makes muscle. Only a little meat is needed by children; too much makes them restless and fretful. Almost the same good can be got from peas and beans as from meat, while they are much cheaper and do not have the bad effect which comes from eating much meat.

VEGETABLES AND FRUIT

Many vegetables contain starch and sugar and other nourishment that gives us strength, heat, and makes the body grow; but they also have mineral matter that is likewise very important. It is well for children to eat many different kinds of vegetables in order to get the minerals which

they contain. Nearly all children like sugar and sweet things, and if eaten in small quantities and at the right time, these give heat and strength to the body.

POTATOES.

There is a good deal of sugar, usually, in the food which is prepared for us to eat, and that is why we cannot eat much more without hurting our stomachs. A little pure candy taken at the end of the dinner as a dessert is pleasing to the taste and does no harm to a well person, and in cold weather a little extra sugar helps to keep us warm.

CABBAGES.

Of course you all like fruit, and it is well if you can have plenty of it; for ripe, fresh fruit makes one feel hungry for other foods, and in the summer it helps to keep one cool and well.

Sugar, starch, and fat help to make us warm, while fruit helps to keep us cool. You will see from this that we should eat more sugar, starch,

and fat in the winter, and in the summer let their place be taken in part by cooling fruits.

With fresh fruit and light puddings for dessert, and occasionally some home-made candy, you will surely be willing to do without rich pies, puddings, and cakes, which do you no good and are likely to do you real harm. There are a few other things which children are much better without; they are spices, mustard, pepper, catsup, and strong meat sauces.

A MELON.

WHERE DOES THE FOOD COME FROM?

IF we, ourselves, were obliged to go and gather all we eat, we should take some very long journeys and see some wonderful sights.

Suppose for dinner we are to have whole wheat bread with butter, salmon, roast beef, potatoes, spinach, rice pudding, and oranges. That will be a good dinner, but I fear we should be very hungry before we had anything to eat if we had to gather together all the raw materials.

The wheat for our bread may be grown near home, or if we live in some places it may be that we must journey far away before we get the wheat. What are the wheat growing states or countries? If we live on a farm we can make our own butter, but many of us do not. We may

REAPING WHEAT.

live where we do not even see the cow which gives the milk from which the butter is made. Perhaps you can tell the best places for cattle raising and butter making. We might use canned salmon, which we could get close at hand, but as we have started to get our dinner from the place where it grows, we must prepare to take a ride on the cars, and a long one, too,

unless we are fortunate enough to live beside one of those beautiful rivers where the salmon lives. Do you know where the home of the salmon is?

SEINING SALMON.

We always think of beef as being fresh, and therefore growing just where we live, but as I sit at my window I can see, some distance away, train after train coming from the West loaded with cattle, sheep, and hogs. Where do they come from? Where are they going? Where are the great cattle-raising parts of the world?

CUTTING SUGAR CANE.

Some of you can get potatoes right out of your own

garden in summer time. But where do the other potatoes come from, and where do we get spinach in winter time? For our rice pudding we must take a trip to the South to get rice and sugar, and

SALT WORKS.

while we are there we might get the oranges. Some of us, perhaps, live nearer to another place where oranges grow. Where do oranges and lemons grow the best?

The milk and eggs we might get near at home,

but we have not yet got any salt, and the meal would be a very poor one without that. Who can tell where we would better go to get good table salt, and what would be the best route to take? Would it not be a good plan when getting

SHEEP.

these products from other places to take something with us from home to exchange for them? What shall we take on each trip?

Where do we get bananas? pineapples? cocoanuts? chestnuts? raisins? dates? figs? prunes?

Where do we get tea? coffee? cloves? cinnamon? nutmegs? pepper? ginger? and mustard?

Where do we get apricots? quinces? blackberries? blueberries? cranberries? and peaches?

Where do we get veal? mutton? rabbit? grouse? quail? and venison?

HOW TO PREPARE FOOD

After the farmer has done his best to raise good grain and good meat and good flour, and the butcher has prepared the meat in the very best way; and after we have chosen those things which are for our best growth in every way, there is still a very important part to be done, and, if it is not well done, it will undo much of the good of the work done before. Unless our food is well cooked, it may not only do us little good, but may do us much harm; we ought surely, then, to know how to cook what we eat.

A very easy way to cook steak or chops is to fry them, but there is another way as easy and much better. We can broil them by holding them over the coals or the flame, and besides giving them a much more delicious taste make them very easy to digest. When meat is roasted, it must have a very hot oven at first that the

outside may quickly brown over and keep the juice of the meat from running out; but it should not cook too long, for the less broiled and roasted meat is cooked, the easier it is to digest. When meat is to be boiled, it must be plunged into boiling water for the same reason that the oven must be hot for the roast meat, but it must then be allowed to cook for a long time, and very slowly, or the meat will become hard.

A cheap cut of meat may be made to give much more food than the same amount of money put into a costly cut, if it is cooked slowly and long enough to soften the gristle and tough parts and to cook the jelly out of the bones. Pork is not so healthful as other meats. When used, it should be cooked very thoroughly to kill the little germs that sometimes live in lean pork.

Butter is a healthful and nourishing food, and may be used plentifully. But it becomes hard to digest when heated, and that is why anything fried in butter, or indeed in lard or other fat, should not often be eaten.

Any vegetable or grain that contains starch should be cooked a long time, for raw starch

takes more than twice as long to digest as cooked starch, and when we do not cook it long enough we make the stomach do more work than it ought to do. Many cereal breakfast foods contain starch, and need to be cooked a long time.

Most children like pancakes, and if they are made of corn meal or graham flour or some other coarse material, and are baked on a soapstone griddle without fat, they are both good and healthful.

These few things have been said just to show that cooking may be made a study just like any other science, and that we cannot be so well or so able to do good work on food that has been prepared without any thought, as we can with thoughtfully and skillfully prepared food.

TABLE MANNERS

We have considered the various kinds of food and the best ways of cooking it, but there are still other important matters to think about before we are ready to eat.

Shall we tumble the food on the table in any disorderly way, and let every one help himself as he pleases and eat in noise and confusion?

The best-cooked dinner in the world would lose much of its good effects if served and eaten in such a fashion.

To get the most good from a meal, we must

eat it in an orderly way and in pleasant surroundings. For this reason we make the table look as pretty as possible. We have the cloth white and clean, because a soiled cloth is unpleasant to see. We have the prettiest dishes we can afford, and we put them upon the table

in the best possible order. We put flowers upon the table if we can have them. We make the food look as tempting as possible when it is brought to the table by arranging it tastefully on pretty dishes and sometimes garnishing the meat platter with sprigs of savory greens, such as parsley or water cress.

But a well-set table is not all. Those who are to sit around it must look their best. There must be no soiled hands nor faces, unkempt hair, nor untidy clothes.

And now the most important thing of all, — there must be no frowning faces, sour tempers, nor cross words. A wise man once said, "Better is a dinner of herbs where love is than a stalled ox and hatred therewith." To say disagreeable things which hurt people's feelings is wrong at any time, but to say them at table is doubly wrong, for an unhappy state of mind interferes with the work of the stomach.

Never tell unpleasant news at the table, nor talk about sickness, death, or terrible accidents. It is an excellent plan to save up the good, funny stories you hear and the most interesting things you read about to relate at the table.

Compliments and pleasant jokes are good table-talk, but never unkind raillery which you would not like to have turned against yourself.

Then there are certain rules about eating that one should learn while young and practice until they have become habits. A few of these are: —

Never carry food to your mouth with a knife.

Never make noises with your mouth while sipping your drink or eating your food.

Never put your fingers in your mouth.

Always wait to be helped.

Never eat fast.

Learn to handle your knife, fork, spoon, and napkin in the proper way.

There are other rules that every one needs to know. Perhaps your teacher will tell you these, and perhaps she will let you have a make-believe dinner party in the school room or on the school grounds some day where the girls can learn how to set the table, and both boys and girls can practice all the rules for table manners.

One of the most important rules for the table as well as elsewhere is: Always be kind and thoughtful of the welfare of others. This will

keep us from one of the rudest of all acts, which is to laugh at other people's mistakes.

A story told of a certain king shows clearly the real spirit which underlies all table manners.

At supper at the royal table were once two ladies from the country, who were not used to good table manners, and they made the mistake of pouring the tea from their cups out into their saucers and drinking from their saucers. Some of the other guests noticed this and began slyly to laugh. As soon as the king saw it, he immediately poured the tea from his own cup out into his saucer and drank from his saucer. The other guests then stopped laughing and followed the king's example.

Thus the two ladies were saved the pain of seeing that they had made a mistake. But it would have been better if they had learned and practiced good table manners at home.

THINGS TO FIND OUT

What are the names of the principal dishes out of which a dinner is served?

On what part of the table are these dishes placed?

Show by a drawing, or by cutting the pieces out of paper, how the plate, knife, fork, spoon, napkin, and tumbler should be placed on the table.

What are some of the most important rules of table manners?

What can girls do to help their busy mothers about getting the meals?

What can they do toward making the home pleasant?

What can boys do to help make the dinner hour an enjoyable one?

What can boys or girls raise in the garden or window garden to use upon the table?

WHAT WE DRINK

We know that without food we could not live long, but without drink we could not live even so long as without food. Nature has provided us with a drink that satisfies all our needs, and is found so plentifully that all may have enough.

The purest water is the rain when it falls from the clouds. After it falls to the ground, it takes from the ground over which or through which it

flows certain minerals, some of which are helpful and others of which are harmful. Water which contains lime is called "hard water." Rain water has no lime or other mineral matter, and is called "soft water." People usually prefer soft water for use in baths and in washing clothes. Soft

water is more healthful than hard water for drinking. It is these minerals that give to the water from different places its different tastes. We miss the minerals from the rain water, and say that it "tastes flat."

In the country people get water from wells sunk into the ground. If the wells are deep, and from one hundred to two hundred feet away

from any foul place, such as a barnyard or cesspool, the water is usually pure. No foul matter of any kind should ever be allowed nearer than this to the well.

In the cities, water is usually brought into the houses through lead pipes. When water stands in such pipes, it absorbs some of the lead, which is poisonous. For this reason, the first water drawn from the faucet after it has stood several hours should be run off and not be used for drinking or cooking.

Once people did not know that certain diseases could be carried from one person to another in the drinking water. Most towns or cities that have a public water supply now look very carefully after the purity of the water that is carried to the people. But in small villages and country places where the people get their water from wells, sickness is often caused by impurities getting into the wells.

During the recent war with Spain, a company of soldiers were encamped in New York State, near a farmhouse. The water supplied to the soldiers was carefully looked after and treated so that it was safe for the soldiers to drink. But

many of the soldiers liked better the water from the well near the farmhouse, because it was so cold. By and by typhoid fever began to break out in the regiment. The physicians examined the water that had been given the men and found that there was nothing wrong with it. Then they questioned the sick soldiers and found that every one of them had been drinking water from the farmhouse well. They went to the farmhouse and found that some one there had been ill with typhoid fever, and by not taking proper care they had allowed the germs of the disease to get into the well.

Another story has been recently told in an English medical paper. Typhoid fever broke out in a certain part of London. The people who had it all lived in the same neighborhood, and the doctors soon found that they all drank water from one certain well in that place. The well was examined, and near it was found a broken drain from which impurities leaked into the well. A curious part of this story was that there were just two people in other parts of the city who came down with typhoid fever at the same time, and it was found that these two had both been

drinking water from that same well in the neighborhood where the others were ill. One had been there visiting friends, and the other was an old lady who had moved away from the place a short time before, but she liked the water from the old well so much that every day she sent there for a jug of it. This showed very clearly that the trouble was with the water of that well.

There is no need of well water becoming a source of danger from such diseases, if people only take proper care to prevent it.

We must look after not only the water supply, but the ice supply as well. A cake of ice looks so clear and pure that it hardly seems possible that there could be anything harmful in it. The purest ice is artificially frozen and made from distilled water. The ice is made from day to day throughout the summer. You may be interested in finding out how men can make water freeze on a hot day in midsummer.

The artificial ice does not supply the whole demand for this cooling and refreshing form of water, so that thousands of tons of ice are stored in ice houses in and near large cities during the winter to be sold the following summer.

Many people believe that freezing purifies water, but such is not the case. If there are germs of disease in the water, they are simply put to sleep by freezing, only to awake and become active as soon as the ice melts.

Great care is taken to get pure water perfectly free from the germs of disease, and from a source not easily made impure. Equal care should be taken to get pure ice. Some companies cut their ice from stagnant ponds or from rivers where the drainage from a village makes it impure. Any disease germs that may be in it are thus not only brought into the house, but actually put into the refrigerator with the food supplies. If ice water is used for drinking, portions of the ice are put into the water pitchers, where it melts and makes the water impure.

Every person should be just as careful to get pure ice as he is to get pure water and pure milk.

Water forms two thirds of the body, and enters into everything we eat. The body needs about two quarts of water a day, and about half of that is supplied in the food. Meat and vegetables all contain water, and it is added to most of the things which we cook. Without water

our lips would parch and our bodies would dry up; without water our food would not digest, the blood would dry up in our veins, and we should die. People sometimes try to make other drinks take the place of water, but none of them can do the work which water does. Some drinks made up of water with lemon juice or other fruit juice added are very healthful and cooling for summer drinks.

Cereal coffee contains food as well as water, and makes a warm drink for winter. Coffee and tea ought not to be used by children who want to grow tall and be strong and well. There is no food in tea and coffee, except in the cream and sugar added. These drinks make children both restless and cross, often taking the place of nourishing food which would help the growth and give strength to the body. Children cannot do their best work in school when they are restless and cross and not well fed. If you have not used coffee and tea it will be well for you never to begin. If you have already begun, make a change and try how well you feel when you drink water, milk, or cereal coffee.

In drinking at meal times it is well to take

water that is not ice cold, and to take it toward the last of the meal rather than at first. Ice water is less healthful than simple cold water. If taken at all it should be sipped slowly enough to allow it to become warm before it reaches the stomach. Children sometimes come in from play very hot and thirsty and drink a good deal of water. It would be better to drink less at a time and be very careful that it is not too cold. Many people have lost their lives through drinking very cold water when overheated.

What do horses and cows drink?

What do young kittens and puppies drink?

What do birds drink? What do plants drink?

Where does your village or neighborhood get its water supply? Is this water soft or is it hard?

WHAT THE MOUTH DOES TO HELP IN DIGESTION

Can you bring to mind the picture of the town upon which we looked from the hilltop?

Do you remember the mill which ground the grain into flour before it was distributed to the different parts of the town? The body has

something that does for it what the mill does for the town. With a mirror you can look into the mouth and see how it is arranged for cutting and grinding the food.

Can you count your teeth? Children under six years have but twenty teeth, but at that age the teeth begin to loosen and come out, and the second set of thirty-two teeth comes in. The front ones are for cutting, and the back ones for grinding. These teeth must last a life-time, for no others will take their place when they come out.

As we shall need teeth as long as we shall need food, and as no others can ever do the work of the real teeth, it will be best to take as good care of them as is possible, and keep them as long as we can.

The first thing toward caring for the teeth is to eat bone-making food. Do you remember what are the best bone-making foods? Then we must see that none of the food remains on the teeth and spoils them. The little particles of food can be taken from between the teeth with a toothpick, never with a hard body, such as a needle or a pin; the toothbrush used once or

twice a day will take off all that gathers on the outside.

The dentist should have charge of the teeth, and by seeing them every year he will care for each cavity when it first appears, and prevent both toothache and the loss of teeth.

Think of something which you like to eat, strawberries or oranges, for example, and see how the saliva flows into your mouth. Even the thought of food makes the saliva flow, and when the food itself enters the mouth, the saliva flows very freely, making the food moist and easy to chew and swallow.

STRAWBERRIES.

It is necessary to chew the food long enough to make it very fine, and to allow the saliva to get to every part of it. Sips of water taken while the food is in the mouth wets the food so much that it does not get enough saliva to digest it.

If food is well chosen, well cooked, eaten at the right time, and well chewed, we need give it no further thought, because the stomach and other digestive organs will take care of it.

HOW THE FOOD IS SWALLOWED

WHEN the food is ready, the tongue pushes it back into the passage from which doors open into other passages. There is an opening for the food, one for the air to go into the lungs, and one by which the air comes in from the nose. If there were no doors, the food might sometimes go up into the nose or down into the windpipe.

When we swallow, the door (epiglottis) over the windpipe shuts down and closes the passage, and a heavy muscle-curtain (soft palate and uvula) swings back against the nose passage. If you laugh and swallow at the same time, the door into the windpipe does not close, and you will have to cough until the food which got into the windpipe can be coughed out again. Sometimes when the throat is much swollen, milk or water, which cannot go down into the stomach, will come out through the nose. If you look at the picture, you will see where each of these passages opens into the large one, and see the doors.

Find out how a bird swallows water. How can a snake swallow a frog larger than his own head?

HOW THE FOOD IS DIGESTED

WHEN the food is swallowed it passes down through a long tube — the *esophagus* — (see Fig. 1) and empties into the stomach.

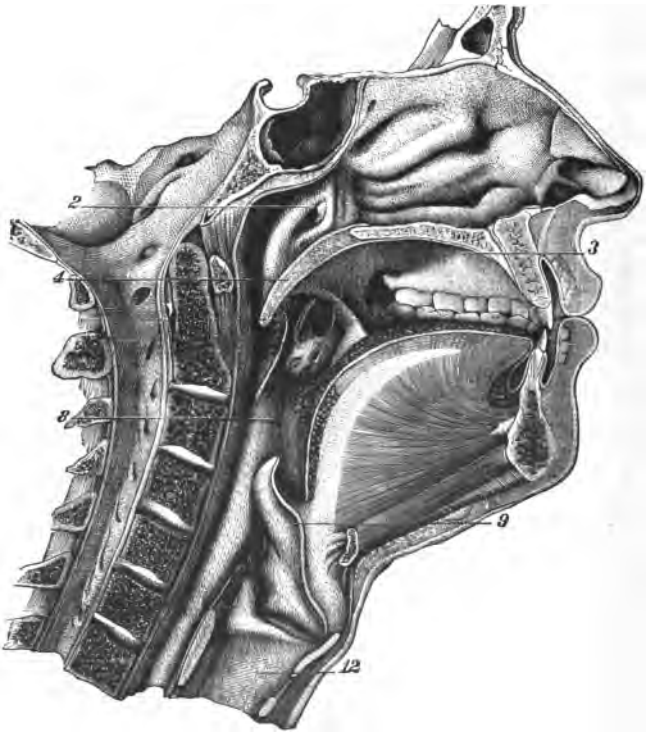


FIG. 1. — Picture showing the pharynx (8) into which the food empties from the mouth (8). The door over the windpipe (12) is the epiglottis (9). The uvula (4) is the muscle-curtain over the nose passage (2).

The *stomach* (see Fig. 2) is the storehouse for the food and is the place where the food is prepared for use. The end of the stomach, into which the food first empties, is the storehouse part, and here the food is held, mixed with *gastric juice*, and then given out at the other end as it is ready. When it goes to the small end of the stomach it is churned and mixed with the *gastric juice*, which softens and changes it until it is "digested," we say.

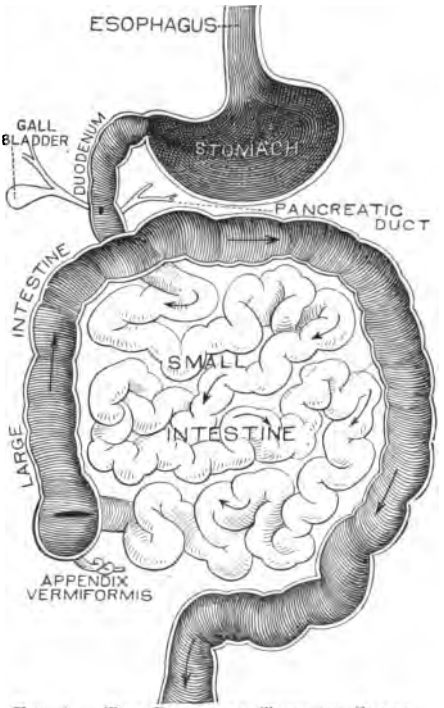


FIG. 2. — THE DIGESTIVE TUBE OR CANAL.

But the stomach cannot digest everything that comes into it; so that after doing all that it can it passes the food on to a long tube — the *intestine* — that has a different kind of juice, which can

complete the digestion. This tube is very long, but is coiled round and round so that it takes up very little room. In the intestine the food becomes almost as thin as water and looks milky. It is then ready to leave the intestine.

Up to this time, although the food is inside of the body, it is not a part of it, but when it leaves the intestine it becomes a real part of the body.

HOW THE FOOD IS TAKEN UP FROM THE INTESTINE

ALL along the inside of the intestine are tiny tubes and blood vessels into which the food oozes through the thin skin that covers them. The little tubes, called *lacteals*, lead to the blood vessels, and empty this new material into the blood. All that has been eaten which does not make blood is carried through the small intestine down into the large intestine to be cast out.

HOW TO TAKE CARE OF THE STOMACH

THE more we eat that is digestible, the more rich blood we make. The more we eat that is indigestible, the more waste material we have.

The more waste material there is, the more work the body does for nothing. The more unnecessary work the stomach does, the more quickly it will get out of order.

The stomach and intestine should not be made to work all the time, for they will surely wear out if they do. If food is eaten at regular times and is of a kind that does not take too long to digest, the stomach can get its work for each meal done in two or three hours and have time to get well rested before the next meal. If indigestible food is eaten or if food is taken between meals, there is either no resting time at all or not enough, and the stomach becomes too tired to do good work.

Children sometimes think that they ought not to eat anything which they do not like, and they are not willing to give up eating things which they do like; but childhood is the time to form tastes. Is it not better to choose those things which are for the best good of the body, and do without those things which do us either no good or do us harm?

Many people think that a drink of cocoa, chocolate, or milk in the middle of the forenoon or

afternoon can do them no harm. Many people eat ice cream and cake, or candy and fruit, between meals. All of the things here mentioned are foods which require digestion. It is just as hard for the stomach to digest chocolate or milk as it is to digest eggs or bread. Milk and chocolate are liquid foods. They do not quench the thirst. All of the things just mentioned should be taken at meal time only, if one wishes to take the best care of the stomach.

The stomach and the whole body may be injured by foods or drinks taken at meal time. Many children drink coffee or tea with their meals. Coffee or tea never does grown up people any good; and they do harm to many people. These drinks always injure children. Professor Spade of Wilmington, Delaware, writing for the *Journal of Education*, says: "Poor ventilation is not responsible for all the dullness and headaches among school children. In our school of two hundred children at least one hundred and seventy were found to be tea and coffee drinkers. And the habit was so strongly fastened upon some of them that they could not well do without coffee for one day. If people only knew how much headache

and other trouble the use of tea and coffee produces, a mighty crusade would be made against their use."

They are positively injurious to children and young people, and many persons beyond middle life would be much better off without them.

If people knew how much these drinks injure a child or young person they would not have them upon the table. Many families are now using such drinks as Postum Cereal or Grain-o. These cereal coffees are nourishing and they do not injure the digestion, cause headaches, or make one nervous or irritable.

In the time of our grandfathers children drank water at the table. The more we study these questions about what is best to eat and drink, the more certain it is that there is no drink so healthful for children and for grown up people as pure water.

HOW THE FOOD IS TAKEN UP BY THE BODY

CAN you imagine a tube about twenty feet long and an inch through, made of such soft skin that

it can be doubled up any way without hurting it? If so, you can think just about how the small intestines look doubled up so that they go into a space less than a foot square. Look at Figure 2 and you will see just how the coils are made.

The whole inside of this tube, instead of being smooth like a rubber hose, has a soft skin that has ridges crosswise of it. The food in passing along through the tube has to go over all these ridges. But even this is not all the roughness of the inside of the tube, for on all of the ridges are little points, or villi, sticking up into the tube.

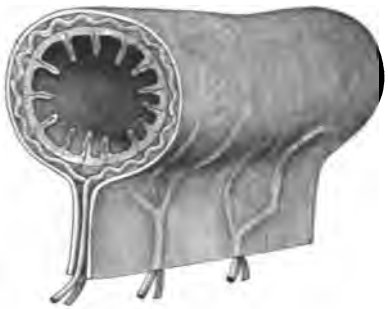


FIG. 3. — A PIECE OF THE INTESTINE (showing the villi at the opening of the piece). — [TRACY.]

You can see that the food will not move so fast through a tube of this kind as it would through a smooth one, and that is one reason why it is rough.

We have already spoken of the tiny tubes or lacteals in the small intestine which take up the

food. These tubes run up into the points, or villi, which project into the intestines. In the picture (Fig. 3) you can see one row of villi; really the whole inside of the small intestine is provided with these villi. In Figure 4 you can see how these villi look when magnified. In every villus there is a tube in the middle around which are loops of blood vessels.

As the food passes slowly along the intestines, the part that is digested soaks through the thin skin over the tiny lacteals or into the small blood vessels which surround it.

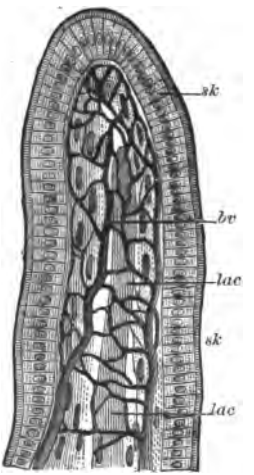


FIG. 4.—A VILLUS, MAGNIFIED.
sk, skin through which the food soaks; *bv*, the loop of blood vessels; *lac*, the lacteals.
—[TRACY.]

All of the starch foods change to sugar, and the sugar foods are taken up by the little blood vessels and flow into larger blood vessels which carry them to the liver.

The liver is a large organ that fills up the most of the upper part of the abdomen, and is the body storehouse for sugar.

This wonderful organ can store up sugar and give it out, a little at a time, as it is needed and

called for by the body. From the liver the food goes with the blood to the right side of the heart.

The fat foods in the intestines are taken up by the villi into the little lacteals (see Fig. 5), which empty into larger lacteals, and are carried by a large tube up to the left side of the neck and emptied into a vein, and so become a part of the blood. The meat foods are taken up by both the lacteals and the blood vessels in the same way as already described. Now we have traced the food from the place where it grew to the place where it becomes a part of the blood.

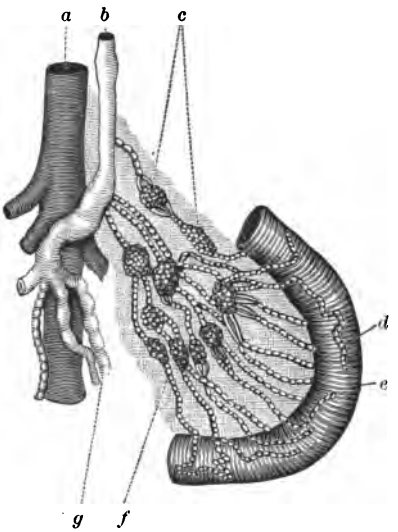


FIG. 5. — THE LACTEALS AND THEIR CONNECTIONS.

a, portal vein; *b*, *g*, thoracic duct; *c*, groups of lacteals; *d*, *e*, intestine; *f*, lacteals. — [JOHONNOT & BOUTON, p. 59.]

Do birds chew their food? If not, how do they grind the hard grains of wheat, corn, and oats which they eat?

HOW THE FOOD IS USED BY THE BODY

If you think back to the lesson on "Why we Eat," you will remember that we had to have food to replace the worn-out material, to add new material, and to keep the body warm.

Most of the food which we eat and which is taken up into the blood and distributed over the body is used by the muscles. The work of the muscles is to warm the body and to make the movements of the body. The food is the fuel of the body, and is used mostly by the muscles in this work. The fuel of the engine is burned quickly and burned with a flame; but the food is burned slowly and without any flame in the body.

All the while, both day and night, food is being used in the muscles as we use coal in the furnace. Just how the food is burned in the body will be described in a later lesson on "How the Body is Warmed."

The muscles and such organs as the liver, stomach, and brain, which do the work of the body, need food to feed and strengthen them for their work.

They find this food in the blood, and as the

blood circulates through them each takes just the kind and the amount of food that it needs.

In growing children, every part of the body must take up food from the blood to add to its size as well as to replace the loss.

What happens to plants when there is no rain for a long time in midsummer?

Which could a person do without longest, food or water?

Every person and animal needs either lean meat or the *albumen* found in eggs and milk and beans and peas and the cereals.

Every person and animal needs either fat or sugar or starch.[1]

What does a horse eat; and where does he get albumen? Where does the horse get fat, or sugar, or starch?

Find out all you can about the food of the fox; the bear; the sheep; the elephant; the tiger; the giraffe; the antelope; the deer.

SOME THINGS THAT HARM THE BODY

We have read about the good which the fresh ripe fruits do the body and what cooling drinks can be made from fruit juice and water; but great harm can be done by fruit juice when it is not fresh.

The fruit with its juice was once a part of a living plant. When fruit ripens, it usually falls from the plant and soon begins to go to pieces. This is the way with all living things. They live for a time, then die and go to pieces or decay. If it were not for this falling to pieces, the earth

[1] Grass and hay and other herbage contain *cellulose*, which is very nearly the same as starch, and can be changed to sugar in the digestive tube of the herbivorous animals, such as the sheep, the cow, and the horse.

would be so crowded with dead forms that there would be no room for new living growths.

But this decay, or falling to pieces, does not go on without means. There are multitudes of small living things, too small to be seen by the naked eye, whose life work is to destroy things from which life has gone.

When grapes or apples are ripe and fall to the ground, they soon begin to rot and go to pieces. This rotting may be caused by plants too small to be seen without a microscope. These plants that cause fruits to rot are called molds or bacteria. Some kinds of them form the mold that you sometimes see on old bread and cheese.

If the apples or grapes are not left to rot, but are gathered and crushed, and the juice pressed out, this juice ceases to be a part of living matter, and will, unless prevented, begin to decay. This decay in the pressed-out fruit juice is started by little plants called yeast plants or ferments. They are different from those that cause the whole fruit to decay. These yeast plants were on the outside of the ripe fruit before it was crushed. When the juice was pressed out, the yeast plants were washed into it, and in a very

few hours they started the process of decay in the following manner: —

The juice as it comes from the ripe fruit is sweet because there is sugar in it. The yeast plants cause the sugar to change into two new substances, a gas and alcohol. The gas passes off in tiny bubbles, but the alcohol remains. The alcohol is a poison. A poison is any substance whose nature it is when absorbed into the blood to injure health or destroy life.

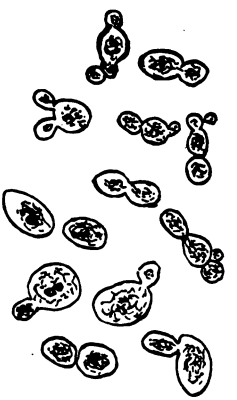


Fig. 6. — Yeast Plant Cells (x 500).

If we did not know about the yeast plant and what it does, we might wonder how there could be anything harmful in cider, which is the juice of apples, and wine, which is the juice of grapes, when apples and grapes themselves are so healthful. If the juice of apples and grapes is used as soon as it comes from the fruits, or if it is cooked and bottled right away, it contains nothing harmful and is indeed refreshing and healthful; but as soon as the yeast plant has time to work in it, and that is only a few hours after it is made, the

sugar begins to change to gas and alcohol. If one needs the acid of fruit juices he can get it in its best state fresh from the fruit, either by eating the fruit or by pressing out the juice and using it before it ferments. It is a law that fermentation changes the nature of the substance it works upon, and fruit juice that has fermented has a different nature from the juice as it comes from the fruit. It is a false idea that it is well to drink cider for the acid it contains. It is better to get the acid fresh from the fruit without the poison that comes from the fermentation of the apple juice. Cider, wine, beer, brandy, and whisky all contain alcohol and are harmful.

A longing for water is *thirst* and a longing for food is *hunger*, but a longing for that which is neither water nor food is neither thirst nor hunger, but *desire*. One cannot have a thirst for alcohol, but he can have a desire for it.

Drinking alcoholic drinks does not satisfy this desire, but creates a still greater desire. That is why people find it so hard to stop using it after having once begun. There is but one way to keep from having a desire for strong drink, and that is not to take the first drink. One drink may con-

tain but little alcohol, but alcohol has the power, though taken in small quantities, to create a desire for more; and this desire may become uncontrollable.

This desire for drink does not grow with the same rapidity upon all. Many do not realize that they have such a desire until it becomes stronger than their will to resist it. Thus the drinker becomes a slave before he is aware. No one expects to become a drunkard when he first begins to drink. Every one who begins is starting out over the same road that every drunkard once traveled.

People who do not know about the power that a little alcohol has to create a desire for more sometimes use it as a flavoring for pudding sauces and other articles of food. There are plenty of other flavorings that have not this danger. No kind of alcoholic liquor is needed as a flavoring in any kind of food and none should ever be used.

The juices of ripe fruits, such as grapes, currants, and raspberries, may be made into delicious and healthful drinks by heating them as soon as they are pressed out and sealing them, while boiling hot, in air-tight jars or bottles. But if the juice

is allowed to stand and ferment after it is pressed out, as is the case with the drinks called "home-made" wines, there will be alcohol in it. No one who understands the nature of alcohol and is truly wise will make or use any drink containing it.

When we put yeast into bread dough to make it rise, the yeast acts upon the free sugar that the flour contains and changes that to alcohol and gas. The gas forces its way through the dough, and in doing so puffs up the dough and makes the bread light. But the alcohol is changed to a vapor by the heat and passed out of the dough while the bread is baking. Thus we can use yeast in making bread, and get light bread and no alcohol, because the alcohol is driven off by the heat.

Alcohol has other bad effects. It inflames the lining of the stomach, and then the stomach not only gives pain, but it cannot do its work of digesting the food well.

Some people think a little wine or other strong drink after a meal helps to digest it. That is a mistake. Instead of removing any trouble caused by indigestion, it dulls the feeling of pain so that people go on eating indigestible foods without knowing, until too late, the harm they are doing.

Beer contains alcohol, and it can do harm the same as the stronger drinks, except that it takes more beer than whisky to injure a person seriously.

The stronger alcoholic drinks are whisky, brandy, and rum. These drinks are nearly one half alcohol.

Some people think that these alcoholic drinks make them stronger; but the fact is that all drinks which contain alcohol make one less strong, less quick, and less alert. For this reason athletes are never allowed to have any of these drinks when they are training for a contest.

Root beer is sometimes made from material sold by druggists. If yeast is used in making the root beer, bubbles of gas will escape from the liquid, and alcohol will be formed and will remain in the root beer. Root beer made in this way may lead to a desire for stronger drinks, and is not a safe beverage.

TOBACCO

A narcotic is a substance which, taken into the system, dulls the senses. The senses are

hearing, seeing, smelling, tasting, and feeling; and all of these senses are made less sharp by a narcotic. Alcohol and tobacco are narcotics.

Tobacco is made from the leaf of the tobacco plant. It contains a poison so deadly that if it were swallowed it would produce death. In smoking, none of the tobacco juice is swallowed, but the smoke itself is very harmful. In chewing, some of the poison gets into the system, although the chewer tries to spit it out.

While tobacco harms, to some extent, every one who uses it, it does greatest harm to the young person who is growing. A boy who uses tobacco, either in cigars or cigarettes, seldom grows to the size that he might have grown, or is able to think so clearly as he might have done. Still worse, the poison makes him not even care that he is not doing the best that he might do.

Another narcotic which does great harm is *opium*. The soothing syrups which some mothers and nurses give to their babies to quiet them contain opium. It quiets the child because it dulls his brain and puts him to sleep, but it may injure his brain all through life. Doctors tell us that the cause of many weak and disordered brains is the

soothing syrup taken in childhood. To get a few hours' release from caring for the baby, by giving him a drug that will injure his brain for life, is a very selfish practice.

THE BLOOD

We have all seen blood, and know that it is red and thicker than water. As we look at it, it seems to be alike all through; but when we put a drop on a glass and look at it through a microscope, we find that it looks like water with many little red and white particles floating in it (see Fig. 7).

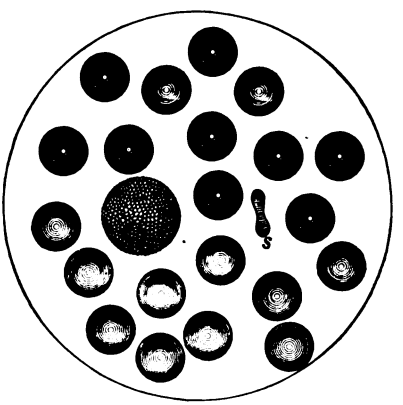


Fig. 7. — This shows the way a tiny drop of blood would look if spread upon a glass plate and viewed under a high-power microscope. Each red corpuscle is a disk which is thicker around the edge than in the middle. One of these disks is shown from the side (*s*). The large spherical, granular body is a white or colorless corpuscle.

There are really three parts to the blood: the colorless, watery part; the red particles, flat and round, called red corpuscles; and the larger rough, white spheres called white

corpuscles. Each of these parts of the blood has a separate work to do in its own way.

The thin, watery part of the blood is the food which soaked through into the veins from the intestine, and contains all the good part of what is eaten and much of the water which one drinks.

There are so many of the red corpuscles floating in the blood that they make the whole blood look red. As the boats carry coal down the river, so these red corpuscles carry a load of oxygen through the blood from the lungs to the tissues. When they give up their oxygen to the muscles and brain and glands, these corpuscles lose their bright color and become a dark purplish color, until they get another load of oxygen from the lungs. Oxygen is the part of the air which the body uses.

The white corpuscles are like the police force of the town, and keep the body from much harm that would otherwise come to it. If a thorn gets into the body, these little white corpuscles hurry to the place, gather around the thorn, and keep it from doing further injury to the body, and at last, by causing the place to "fester," they push it out.

If, in our town water system, a hole is made in one of the pipes, the water keeps running until the hole is mended; but if a similar thing were true in our bodies, we might die before the leak could be stopped. When the finger is cut the blood runs, sometimes very fast at first, but soon more slowly, and after a time it stops running altogether.

In some way when blood is open to the air it thickens, and this thickened blood fills up the cut and stops the flow of blood.

The blood will thicken more quickly by the use of hot water, while cold water will make it flow longer.

If a large vein or artery is cut, the blood runs so fast that one would soon lose enough blood to cause death if the wound were not tied up.

If one wants good red blood, he must eat good healthful food, take plenty of exercise, and breathe plenty of fresh, pure air.

Rich, pure blood gives the red color to lips and cheeks, the strength to the body, and the power to think well.

HOW THE BLOOD IS CARRIED OVER THE BODY

Let us take another look at our town, and again notice the great system of pipes going out from the pumping station, carrying fresh water to every part of the town, then into every house, and at last to different parts of each house, where we shall find another system of pipes gathering up from each house the waste, which is then emptied into larger pipes, and later into the main sewer, to be carried to some stream of water, which will carry it to the sea, where it will be made pure again.

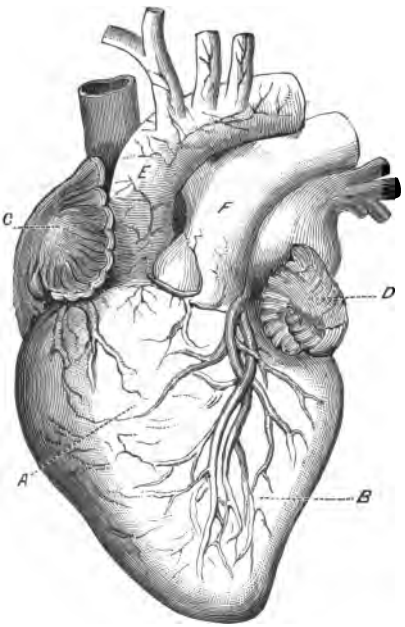


FIG. 8. — THE HEART.

A, the right side, which receives impure blood from the little chamber *C*.
B, the left side, which receives pure blood from the chamber *D*.
E, the large artery carrying pure blood from the heart to the body.
F, the large artery carrying impure blood from the heart to the lungs to be purified. — [JOHONNOT & BOUTON, p. 71.]

If you bring this all to mind again, it will help you to understand the two great systems of pipes in our bodies.

The heart (see Figs. 8 and 9), although not larger than the closed hand, is the pump which sends the stream of blood over the body.

From the left side of the heart are large tubes or arteries which soon divide and send branches to the head, one to each arm, one to each leg. These all divide again and again, until there are a great number of very tiny arteries in every part of the body. If you look at the picture (Fig. 10), you will understand better how these arteries look.

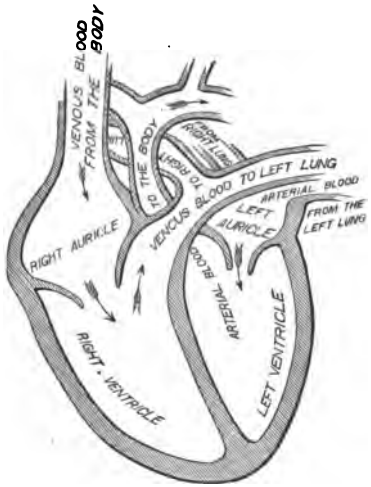


FIG. 9. — This shows the way the heart is partitioned off inside. See if you can trace the course of the blood after it enters the right auricle from the body. — [TRACY, 149.]

Every time the heart beats, it pumps the blood through all these large pipes into the smaller ones, and finally into the smallest ones, — the

capillaries, — whose walls are so thin that when the blood is forced into them by the beating of the heart, it oozes right through the walls and gives up its food to the muscles, nerves, bones, and skin that are near.

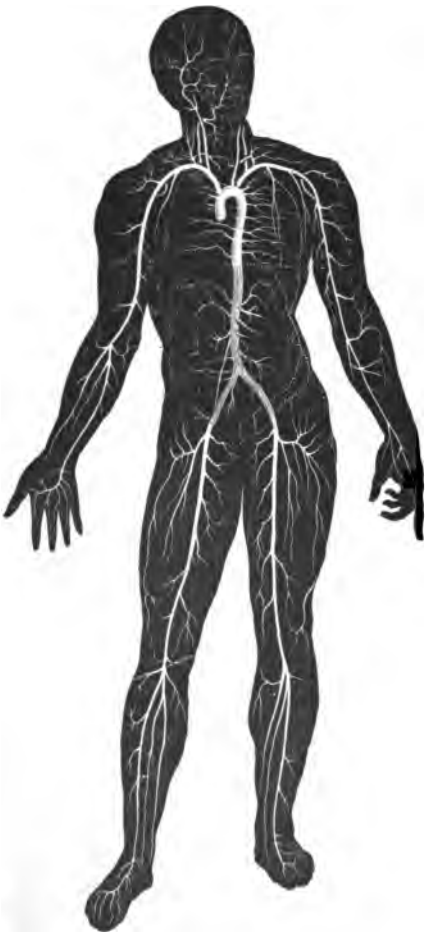
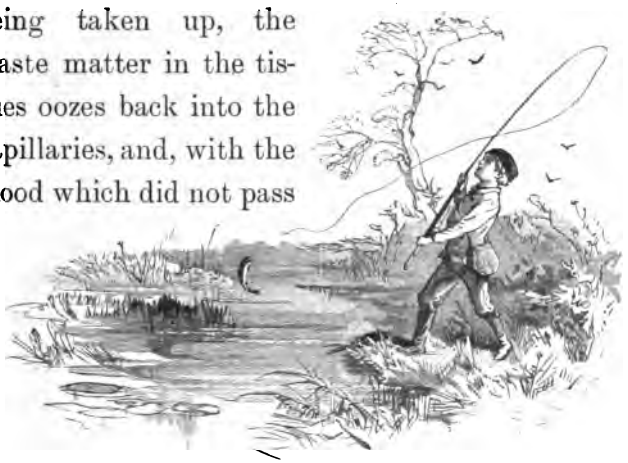


FIG. 10. — ARTERIAL CIRCULATION.

People who live by a river may get the water which they use and perhaps some of their food (fish) from the river. At the same time the drain from the house may carry the waste matter from the kitchen and bath room and pour it into the river. So that the

river serves the double purpose of bringing food and drink and of carrying away waste materials. Figure 11 shows how the arteries distribute the blood to the tissues through the capillaries.

Each part of the body can take from the blood just such things as feed it best. While this is being taken up, the waste matter in the tissues oozes back into the capillaries, and, with the blood which did not pass



through the walls, is carried on in a second set of tubes — the veins, which carry all the waste that is given off by the body into larger and still larger pipes or veins, until it again empties into the heart, but this time into the right side.

The heart has two separate sides with no door between, and into the left side all the red, pure blood flows, while all the impure blood flows into

the right side. From the right side of the heart the blood is sent to the lungs.

Do you see why the course of the blood is called its circulation? Because it starts from

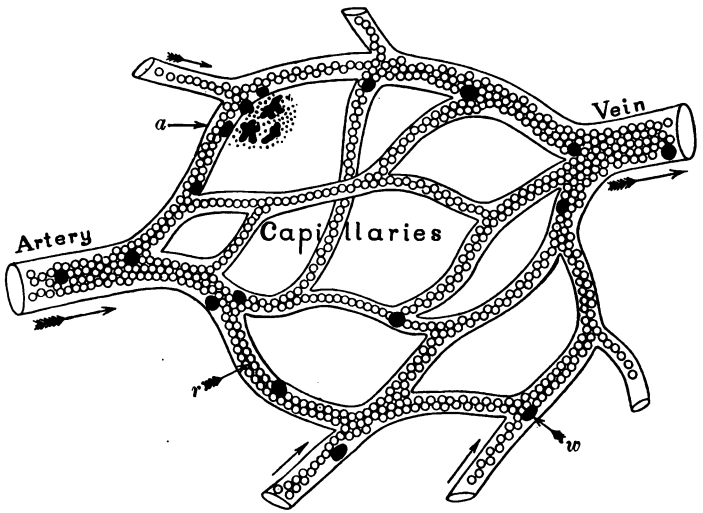


FIG. 11. — This shows how an artery divides into small capillary branches. The blood slowly flows or filters through the capillaries and then gathers into a vein and flows away to the heart. The lighter shaded bodies (*r*) are the red corpuscles carrying oxygen to the tissues. The larger, darker bodies (*w*) are white corpuscles. In one place (*a*) the white corpuscles have gotten out of the capillary into the tissue to destroy some minute disease germs that might seriously injure the body if they were not destroyed by the white corpuscles.

one place, flows out to different parts, comes back to the same place, and then goes over and over this same course. It *circulates* over the body.

THE HEART BEAT AND THE PULSE

PUT your hand on your left side and feel the beating of the heart as it is pumping the blood through the arteries. You could count each beat if you tried, and tell how many times the heart beats in a minute, and could see that the heart beats at nearly the same rate all the time.

With the tips of the fingers of one hand feel the wrist of the other hand and find the beating or throbbing artery. The throbbing of the artery is called the *pulse*. All of the arteries pulsate or throb with each beat of the heart. The reason we do not feel them is that the arteries are usually buried deep among the muscles near to the bone. Sometimes an artery lies near to the skin, and then one can feel it pulsate. The pulsation is caused by the beating of the heart, and has, of course, just the same rate as the heart beat.

Such exercise as running and jumping, and such work as keeps the body in motion, make the heart beat faster and work harder. Exercise and work make us tired and we need to rest.

Sometimes, when one is frightened, the heart

does not beat in regular time or with regular force. This is very hard on the heart, and should be avoided if possible.

HOW NARCOTICS AFFECT THE HEART

Alcoholic drinks and tobacco may also make the heart beat too fast and unevenly. This gives the heart too much work, and makes it "irritable" we say. That is, it beats fast, then slow, and fast again, instead of beating evenly. It is dangerous to have a heart in this condition, for it may in a serious case stop beating altogether if one receives a fright or takes much exercise. Beer may make fat collect about the heart or in its walls, and make it too weak to do its work properly.

When we know that the whole work of the body depends upon the heart, we shall be very careful to do nothing that will weaken it or make it less able to do its work.

When one runs the heart beats fast and strong in order to pump enough blood to the muscles. So you see that when one runs he exercises not only the muscles of his legs and hips, but also

those of his chest that cause the lungs to fill, and those in the walls of the heart.

Running is good for boys and girls because it makes all of their muscles strong, and because it makes the lungs and heart strong.

It is very important to have a strong heart. The games and races which boys and girls have at school are very important; and every boy and girl should try to excel in them. If one gets a strong heart in youth it may help him to keep well throughout life.

The principal work of the white corpuscles is to guard the body against disease. When alcohol is taken into the stomach, it is absorbed into the blood, where it injures the white corpuscles and makes them less able to do their work. This leaves the body less able to resist disease. Persons who use alcoholic drinks are thus more likely to get sick than are persons who do not use them.

SOMETHING TO FIND OUT

Count the pulse of a playmate or of yourself, and find how many times it beats each minute.

Does it make the heart beat faster to run or to jump or to climb stairs? If so, how much?

Put your ear over the place where your playmate's heart is beating and listen to the heart. What is it saying?

Perhaps the butcher will get the heart of a sheep or calf for the class to study; or, perhaps, a member of the class can bring the heart of a chicken or turkey from home. Make slices across the heart from the tip toward the base, until half of the heart is thus sliced; make drawings of the largest of these slices. How does the left ventricle differ from the right? Now cut the ventricles open; study the valves; draw pictures of them.

HOW THE BLOOD IS MADE PURE

In an earlier lesson we read that the impure blood emptied into the right side of the heart, but there we left it without saying what became of it.

If this impure blood were to go back over the body, it would poison it and make the person sick; but before it is used again it is changed. We must learn how this change comes about.

Put your hand on your chest and notice how it rises and falls all the time. If you wish,

you can make it rise and fall very much or very little, and you can make the pauses between the motions long or short. That is the most that you can do with it, and as soon as you stop thinking about it, it goes on again as before.

We know how needful it is to have water and food, but we can do without these longer than without the air which we take in with each rise of the chest. In the opening into which the food goes when swallowed there are, you remember, two air passages besides the passage into which the food empties.

THE ORGANS WITH WHICH WE BREATHE

CLOSE the mouth and draw in the breath, and you will feel the air passing through the nose opening. Be sure to breathe through the nose, as it will prevent particles of dust from going into the air passages, and the air will be warmed before it reaches the delicate linings of the air tubes. It passes the muscle-curtain which is drawn away, enters the large passage which serves for both food and air, and when the little door over the windpipe is lifted, it enters the windpipe.

Feel the throat with the fingers, and you will find the "Adam's Apple." Notice that when you swallow, this organ — the *larynx* — moves quickly upward; that brings its open upper end close to the root of the tongue, where the epiglottis can keep food or liquids from going down into the windpipe (see Fig. 1).

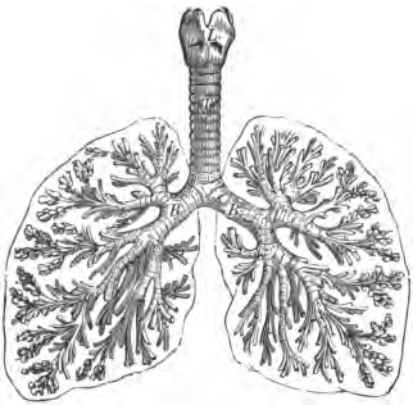


FIG. 12. — THE WINDPIPE AND ITS BRANCHES IN THE LUNGS.

L, the larynx; *T*, the trachea; *B*, the bronchial tubes, whose small branches are called bronchioles. The little tufted sacs at the ends of the bronchioles are the air sacs or air cells of the lungs. — [TRACY].

Feel the throat below the larynx. One can easily find the rings of gristle which keep the windpipe open.

Look at the picture (Fig. 12) and you will see this tube, — the *windpipe*, — and see how it branches, and branches again, into the tiny branches which you see at the end. These tubes enter the lungs just before they send off the first branches, and all of the branching is done within the lungs.

The lungs lie one in each side of the chest, and are like two large sponges which take up air instead of water. They are elastic, like rubber, and become larger when filled with air and smaller when emptied.

The lungs are elastic because they are composed of many, many tiny air sacs which are elastic, and expand and contract.

WHAT TAKES PLACE IN THE LUNGS

When one draws a full deep breath, the air goes down the windpipe, out through all the branches, into the little sacs at the end of each branch.

When the air is breathed out, these little sacs are emptied, and the air passes out the way it came in.

If this were all the air did, simply to go through the tubes into the lungs and through tubes out again, it would be a great deal of work for nothing; but if the air which goes into the lungs and the air which goes out be examined, it will be found that a change has taken place. To understand this we will go back a little.

We left the blood in the right side of the heart, but from there it was carried in tubes to

the lungs, where the plasma of the blood gave up the impurities it had collected in the different parts of the body, and took in a new load of oxygen to carry back to the left side of the heart. It is the red corpuscles of the blood that carry the oxygen from the lungs to the tissues. From the left side of the heart the blood is pumped through the arteries, each corpuscle bearing its load of oxygen to the muscles, glands, and brain.

WHY WE NEED PURE AIR

We have learned that the air which goes into the lungs carries the *oxygen* that keeps the blood red and pure, and that the air which we breathe out from the lungs contains less oxygen, more water, and a gas which the blood brings from the tissues and gives up to the lungs. This gas is called *carbon dioxide.* It is the same kind of gas as that which is given off from the yeast plant when it is causing fermentation.

If the purity of the blood depends upon the oxygen in the air, you will readily see that the purer the air the better it is for the body.

If the air which has been breathed loses oxygen

and gets carbon dioxide, it certainly is not fit to be used over and over again.

THE CARE OF THE LUNGS

Most people do not realize that they need to take any thought or care of the lungs, but it is just as important that they be exercised and developed as that the muscles be exercised and developed.

One should early form the habit of taking daily a few minutes of deep breathing in the open air. In taking this exercise one should stand with head erect and shoulders back, and should draw in just as much air as possible. After holding this air for a few seconds, it should be allowed to flow out slowly and the lungs completely emptied. This "forced respiration" should be repeated over and over again for at least five minutes. If one were to do this every morning and evening he would make his lungs so large and strong that the germs of disease would probably never lodge in them.

Besides this forced respiration one needs to take some brisk exercise like rapid walking, running, swimming, skating, rowing, cycling, or fast riding on horseback. All of these exercises require rapid and deep breathing, and all of them develop the

lungs and make them strong enough to throw off the germs of consumption which we take in with the breath every day, if we live in a large city.

VENTILATION

When a room is shut up tight and several persons are breathing the air, it is not long before there comes to be so much of the carbon dioxide and so little of the oxygen that it does not purify the blood.

Have you not noticed how red and hot the cheeks become, and how the head aches after sitting in a room which has not enough oxygen? These things are only to warn one that the body has not enough oxygen, but the real harm, that cannot be noticed at once, is much greater than this.

There should be some way for fresh air — that is, out-of-door air — to enter the room in which one sits, works, or sleeps. There need not be a large opening, nor need it always be in the same room which one occupies; but it ought to be enough so that the air is changing all the time without making a draught.

In schoolrooms where there are so many people breathing the air at one time, there must be some

special way for the pure air to come in and the foul air to go out, or else each pupil will breathe the impure air thrown out as waste by the others.

Not only is this unpleasant, but it poisons the blood and makes the school work very hard to do. Pupils can do much less brain work in impure air than in pure air.

Most of the catarrhs, sore throats, and other forms of colds are contracted from the want of proper ventilation. It is possible to catch as bad a cold in a close, ill-ventilated room as in a cold, draughty one. Pure air is the surest preventive of colds, as of many other diseases.

When exercise is taken, much more air is breathed into the lungs, as more air is needed. We should therefore take great care to have this air pure. There is little danger of taking cold while we exercise if we go to a warm place after we stop exercising.

When you go from the pure out-of-door air into a room you can tell very quickly whether the air inside is fit to breathe. If there is a close or bad smell about the room it needs airing.

When one is sick, the little white corpuscles need a plentiful supply of oxygen for carrying on

their work of fighting the disease. The sick room, therefore, should be always well aired. There is no danger of taking cold if one is covered up warmly and is not in a draught. There is always danger, whether one is sick or well, in breathing bad air.

In ordinary breathing we do not completely fill the lungs with air. It is a good practice to take frequent, long, deep breaths of fresh air, filling the lungs and holding it while you count ten. This enlarges and strengthens the lungs, besides aiding in purifying the blood.

EFFECT OF ALCOHOL AND TOBACCO ON LUNGS

A noted physician of Paris says that he finds that many of the alcohol patients discharged from his hospital very soon come back to be treated for consumption. This is the opinion expressed by many other medical writers. The reason given is that alcohol makes the body less able to resist the germs of consumption which may be in the air, but which cannot get a chance to begin their work when the body is strong and in vigorous health.

Physicians have found that people who use

alcoholic drinks regularly are more likely to have pneumonia and certain other lung diseases than are people who do not use such drinks at all. Besides this, when a drinking man gets pneumonia, he is likely to have it more severely than is the total abstainer and is less likely to recover.

The use of tobacco irritates the lining of the throat and causes the mucus to flow more freely than is natural, and this is likely to cause an inflammation of the throat.

THINGS TO FIND OUT

How many breaths does one naturally take in one minute when sitting quietly?

Does one breathe faster after running two blocks or after running up two flights of stairs? Does one breathe more deeply after such exertion? Why is the breathing changed when one exercises vigorously?

How does a frog breathe?

How does a bird breathe?

How does a fish breathe?

How does a crayfish (crab) breathe?

Does a plant breathe? If so, what does the plant have that corresponds to our lungs?

THE WASTE MATTER OF THE BODY AND HOW IT IS THROWN OFF

In the town which we visited, all water that was used was carried off in pipes and thrown away. To be sure, it went into streams of water which finally carried it to the sea, from which it was in time evaporated by the sun, floated away in clouds, and was brought back as pure rain water for use again.

In the body we have seen that the blood circulates over and over again, being made pure in the lungs and used over again in the same body.

There is a good deal of waste, however, that has to be thrown out of the body. The undigested food, which never becomes a part of the body, is carried along the large intestine until it is expelled. This waste material should be expelled every day, as some of the unclean matter from it will soak through the walls of the intestine if it stays there long, and will be taken up into the blood and poison it. People sometimes have fever from this poison.

The special organs for sending out the waste are the kidneys. The kidneys of a person are

bean-shaped organs that are just about long enough to cross the palm of the hand. They lie in the abdomen back of the intestines, and next to the small of the back. Large blood vessels carry blood to the kidneys to be purified, and other large vessels carry it back to the veins in which it returns to the heart.

These organs have the power to separate the waste water and other waste matter from the blood. Some of these waste materials would poison the body if they were not cast out. When too much of our food is meat or when one overeats of any kind of food, the kidneys have too much work to do and may become diseased.

We can help keep the kidneys in good order by eating moderately and by drinking plenty of fresh, pure water. It relieves the kidneys if one flushes the system sometimes by drinking a great deal of water. Lemonade also helps the kidneys to throw off waste matter.

Of the work which the lungs do in casting out waste we have already spoken, and of other organs whose work is in part that of carrying out the body waste we shall speak in the next lesson.

THE SKIN AND ITS WORK

THE first use of the skin is to protect the body. It covers the muscles and keeps them from being bruised or torn.

The skin is composed of two layers, an outer thin layer which has no blood vessels and few nerves, and an inner layer which has many blood vessels and nerves. In the outer layer is the coloring matter which gives a person a dark or light skin. This layer seems when touched to have feeling, but that is caused by the outer layer pressing upon the nerves of the inner layer.

Over most of the body the outer layer of the skin is very thin, not thicker than paper; but over the palms of the hands and the soles of the feet — places which come in contact with hard and rough substances — the outer layer or cuticle is very thick and tough.

The outer layer of the skin tends to thicken when it is rubbed or pressed for a long time in the same place. This is the cause of the callouses that sometimes come on the inside of the hand.

The lips and the inside of the body are covered by skin of a little different kind. This is thinner and gives out a fluid which always keeps it moist.

The corns that form on some people's feet are caused by the rubbing or by the pressure of the shoes. Shoes should not be too tight or too loose. If they are of soft leather and fit the feet snugly but not tightly, there should be no corns upon the feet.

The skin has another very important work. Look at the palm of your hand and you can see the tiny lines or ridges running all over the hand. If your eyes were sharp enough, or if you had a magnifying glass, you might see on the ridges many little dark spots.

The spots seen in the skin are really tiny openings. Each opening is the mouth of a small tube or pipe (see Fig. 13). This is a sweat tube, and it runs down through both layers of the skin. Just below the under layer it forms a coil. This coil is the sweat gland, which collects the sweat or perspiration from the blood.

The sweat which collects in these little coils passes through the tubes, and on a warm day you can see it standing in drops on the skin.

If there is much of it, it runs off, but when less it dries up.

One perspires all of the time, whether it can

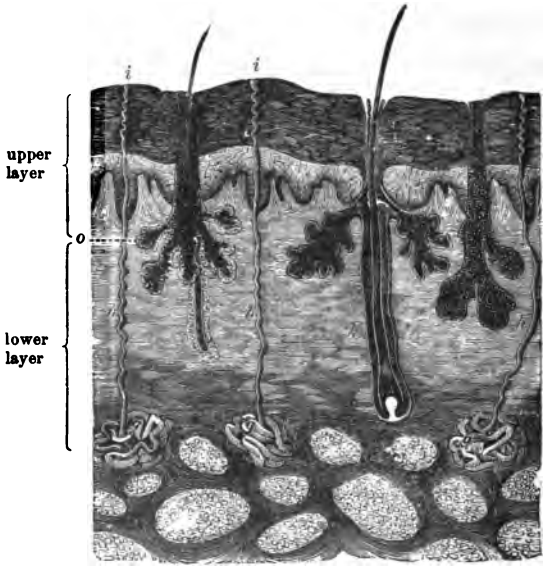


FIG. 13. — THE SKIN SHOWING THE UPPER LAYER AND THE LOWER LAYER.

h, the sweat tube. *g*, the sweat gland. *i*, sweat pore.
k, the hair tube. *o*, the oil gland.

be seen or not. Indeed, nearly a quart of waste water goes off in this way each day.

It is only the water part of the waste that dries up, and the rest stays on the skin until it is washed off. That is why our bodies become unclean, even where covered with clothing.

To get rid of this waste that it may not fill up the sweat tubes so that the sweat cannot get out, we need to give the body a thorough washing with warm water and soap at least once a week.

Besides the sweat glands of the skin, there are other glands which make oil. They pour out this oil to keep the skin soft. Dark skins seem to have more of this oil than fair skins, and sometimes it is necessary for fair people to add a little oil to the skin after a bath to keep it from getting rough or sore.

HOW ALCOHOL AFFECTS THE SKIN

Persons who use alcoholic drinks freely are likely to get very red faces. This is because the little capillaries or blood vessels of the skin are weakened so that the blood which is being forced through them by the heart pushes their walls out and makes them much wider, so that the skin contains much more blood than usual, and that is what makes it look red.

If one takes these alcoholic drinks only a few times, the skin recovers; but if their use is continued for many months or years, the little blood

vessels finally get so weakened that they cannot recover after each use of the alcohol, and so remain permanently enlarged.

THE HAIR AND THE NAILS

THE hair, the nails, and the teeth look so different from the skin that we do not think of them as being the same, and yet they are formed of the same material, and all but the teeth are a part of the body protection.

The nails give firmness and strength to the ends of the fingers and toes, and help in picking up things. They are continually growing, and should be kept trimmed with a sharp knife or scissors, but never by biting or breaking. It is so easy for dirt to get under the nails that they need careful cleaning each day.

When we speak of the hair we usually mean the hair on the head, but, in fact, there is hair all over the body except on the palms of the hands and the soles of the feet.

Hold your hand to the light and look across the back of it. Do you see the little short hairs? There are just such hairs over most of the body.

Look at the picture (Fig. 13) and see how the root of the hair runs down through the upper layer of the skin, and how the oil gland empties at the base of the hair. The oil not only keeps the skin smooth, but it keeps the hair oiled. When the hair is well brushed, it causes the oil to flow and make the hair look glossy.

Dark hair is likely to be much more oily than light hair because the oil glands work more in dark-skinned people.

Brushing helps to keep the hair clean by removing the dust; but the hair should be washed often enough to take away the collected oil and give a chance for the fresh oil to flow.

It is possible to wash the hair too much, but that very seldom happens.

Girls who have long, heavy hair often dread to have it combed. But they need not if it is properly done. Starting the comb from the head and dragging it down to the end of the hair without regard to snarls and tangles is not the best way to take care of the hair, and this kind of combing is, of course, painful; but if the hair is held in the hand, the comb is started at

the ends of the hair, and the snarls worked out little by little from the ends up toward the head, there will be no pulling, no pain, and no damage to the hair.

The small hairs that cover the body do not come straight out from the skin, but slanting, and all those that are near together lie in the same direction.

When the skin is warm the hair lies down. When cold strikes the skin these hairs all rise and stand up straight. This rising of the hair pushes up a bit of skin around each hair, and makes what we call "goose flesh."

Sometimes in fright the hair of the head rises in this way, and we say, "The hair stood on end."

THINGS TO FIND OUT

Did you ever see the hairy coat of a horse or cow lose its glossy smoothness when the animal is led out of a warm barn on a cold winter day? What has happened and why has it happened?

Did you ever notice that when a dog is angry the hair upon his neck will rise? Why does nature provide for a dog in this way?

Did you ever see the hair upon a kitten's back

and tail rise? If so, under what circumstances? Why are they provided by nature in this way?

Why do we have "goose flesh" when the skin becomes suddenly chilled? Is this a provision of nature? If so, what is its purpose?

BATHING

HAVING seen how much our health depends upon our bodies being clean, we will talk about some of the ways of keeping it so.

As the face, ears, neck, and hands are not covered, they collect much that is unclean from

the air, and must be washed more often than the rest of the body. But the skin of the entire body, as we have seen, collects uncleanness from within which must be washed away.

For simple cleanliness a warm bath with soap once or twice a week is enough, especially if the skin is rubbed hard enough to take away the dead scales of the skin, and the oil with the dust which sticks to it.

There are other uses of the bath besides that of cleanliness; one very important one is lowering or raising the temperature of the body.

If every morning before dressing one should wash the entire body with cold water, uncovering, bathing, and rubbing only a portion of the body at a time, it would make the person much less liable to take cold.

After a sponge bath of this kind, a good hard rubbing should be given the skin so that it is left warm and glowing. Washing with warm water in the morning for cleanliness should always be followed by a dash of cold water to prevent taking cold. Every bath should be followed by rubbing with a coarse towel until the skin is red and glowing.

In summer time, when the body gets heated and one perspires much, it is both cooling and restful to take a sponge bath at night, using cool water, which gives one a refreshed and rested feeling.

Although baths are so needful for cleanliness and health, they must be taken at the proper time in order to do the most good and in some cases to keep from doing harm.

For an hour after eating the stomach needs an extra amount of blood to digest the food. If a bath is taken during this time it draws a large portion of the blood to the skin, and the stomach, for want of it, cannot so readily digest the food. It is bad also to draw the blood from the stomach just before a meal. It is better, then, not to bathe just before or just after a meal; and, as bathing opens the sweat tubes and makes the skin more sensitive to cold, it is better not to go out of doors directly after a bath. Exercise raises the body temperature, and a bath taken just after violent exercise or at any time when one is overheated is likely to give a shock and make one ill.

In summer, when one can bathe in the river,

lake, or sea, the same general rules should be followed, and care must also be taken that the pleasure in bathing does not lead one to remain too long in the water.

BATHING BEACH, COTTAGE CITY, MARTHA'S VINEYARD.

Even though the water is warm, the out-of-door bath should not last more than twenty or thirty minutes, and for many people fifteen minutes will be found quite long enough.

CLEANLINESS AND HEALTH

WHILE we are talking about the bathing of the body for cleanliness, we may as well talk about cleanliness in general, because it is quite as important to keep the house with the kitchen and dining room utensils and dishes clean as it is to keep the body clean.

People who keep their bodies clean are quite sure to keep their clothing and their house clean.

Clothing which is worn next to the skin takes up impurities which are thrown out of the body, and must be thoroughly washed in hot water and soap at least once each week, and oftener in summer. When washed clothing is drying it should hang in the open air; for nothing except the pure out-of-door air can give to clothes the sweet, clean smell that every one enjoys.

Bedding should be aired daily and washed as often as once each week. This seems an unnecessary rule of housekeeping to give to American youth; but there are many foreign countries where the bedding is washed not

oftener than once in a month, or even once in three months.

Cleanliness in the kitchen and dining room is also important. When the table is immaculate, the dishes shining with cleanliness; when the kitchen floor, table, and sink are spotless; when the utensils shine, there is not much opportunity for the germs of disease to remain in the house even if they are brought in accidentally. The refrigerator must also be cleaned and aired once each week, and the cellar or basement must be clean and well aired.

Houses that are kept in this way are healthy places for children to grow up in.

Schoolhouses and other public buildings must also be kept clean. People who occupy public buildings are under obligations to the community at large to keep the buildings as clean and neat as possible.

Books in school libraries and in public libraries should be handled by clean hands only, so that these books may remain clean even though they may be in constant use for months. If one must use a soiled book from a public library he will be wise to wash his hands afterward.

ALCOHOL AND BATHING

It is thought by some that a drink of whisky after taking a bath will prevent one from taking cold. If you have understood what has been said before about the effect of alcohol upon the skin and its effect on the warmth of the body, you can now see that, if alcohol makes the blood come to the skin, it will lose some of its warmth, and though the skin feels warm and comfortable at first the body gets chilled later and one is more likely to take cold. Nature's method of making the skin glow by vigorous rubbing is the only safe way. People who take cool or cold morning baths followed by rubbing until the skin is red and glowing very seldom take cold.

HOW THE BODY IS WARMED

CLOTHING is worn, especially in cold weather, to *keep* the body warm. Can it do more than that, can it make the body warm?

Try wrapping up a piece of iron or wood in a shawl; will it become warm? Does a doll become warm because of its clothing?

Clothing adds nothing of warmth to the body,

it simply keeps the warmth which the body already has from leaving. The more clothing we wear the warmer we become because the less heat escapes.

Where then does the body get the heat which the clothes keep in?

Under the subject of foods we learned that part of what we eat is used for heating the body, and that starch food, sugars, and fats are the greatest heat makers.

To understand just how this is done is not easy.

You have seen an engineer put coal on a fire, you have seen that the fire makes the engine go, and perhaps you have felt the heat from the fire. If the fire box were shut up tight so that no air could get in, the engineer might put ever so much coal on but the engine would not go and you would feel no heat; indeed, the fire would go out.

It is the oxygen from the air that makes the coal burn and give out heat, and that is why there are drafts in all stoves and furnaces. These drafts provide a way to let much or little oxygen reach the fire according as we want much or little

fire. Even when we shut the stove or furnace as tight as we can, enough air can get in through the cracks to keep the fire burning for a time.

The oxygen which we breathe makes the food, which is body fuel, give out heat, and enables us to move. The oxygen and the coal burning in the engine give out heat and enable it to move.

When the fuel of the engine is used up there are smoke and ashes left, and when the fuel of the body is used up there is waste that corresponds to the smoke and ashes.

The undigested food which the intestine carries off is like the ashes, and the waste carried off by the skin, the lungs, and the kidneys is like the smoke.

Now we know how the body is made warm, let us see how nature planned to keep it warm.

To the skin has been given a part of the work of regulating the heat of the body.

If one becomes too warm, the sweat pours out of the sweat tubes and the water passing into the air cools the body. The reason we feel so much warmer on a moist hot day than on a dry day is that this moisture cannot go out into the air.

We can, in a measure, regulate our tempera-

ture by food, clothing, and exercise. A rapid use of the muscles warms the body. Running, jumping, or any play or work that makes the muscles active are good ways of warming the body.

The hair which covers the head keeps it from feeling every little change of temperature. In lower animals the temperature is partly regulated by the hair which covers the body. When it rises and looks rough it makes a thicker, warmer coat than when it lies smooth and glossy close to the animal's skin. This is the way a horse, or cow, or dog, or cat puts on an overcoat.

It used to be thought that a drink of some alcoholic beverage would "warm one up" on a cold day. What it really does is to make the blood come to the skin. That is warmed, and the person thinks at first that the alcohol has warmed him; but the body loses heat so rapidly that it soon becomes chilled and much colder than it would have been without the alcohol. Many men have lost their lives by taking whisky to keep them warm on a cold day. Men who travel in arctic lands avoid alcohol because they know its dangers. Some people take alcohol to make them cool in hot weather. It may perhaps

make them cooler at first; but men who use alcohol are much more likely to get sunstroke than are men who are total abstainers.

SEEING

How many beautiful things there are in the world. I wonder if you really know how beautiful and wonderful they are. Sometimes we grow so used to nature's beauties that we do not see their beauty.

Think of the sky with its countless stars, the trees with their bright foliage, the flowers that grow at our feet.

How much of pleasure lies in beauty, yet all this would be lost to us without the sense of sight.

Think, too, how many things you do which depend upon your seeing well, and then you will realize how valuable this sense is.

Look about and see how much there is that is beautiful and how much there is to see. After looking at an object you can shut your eyes and can still see it with your mind.

If you had never had eyes, you could not bring pictures to mind as you now can. You could tell

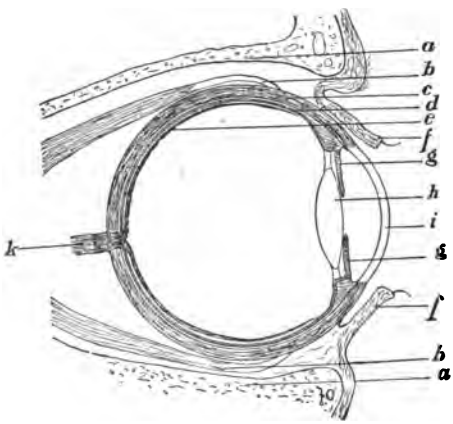


FIG. 14. — SECTION OF THE EYE.

a, bony case of the eye; *b*, muscle to move the eye; *c* and *d*, coverings of the eye; *e*, lining or seeing part of the eye; *f*, eyelid; *g*, colored curtain or iris; *h*, and *i*, clear windows of the eye.

the shape of objects by feeling them, but without sight all sense of color would be lacking.

The eye, itself, is the shape of a sphere (Fig. 14), and rests on a cushion of fat in a bony hollow or socket. The upper edge of the socket stands out and forms the brow which protects

the eye. The skin over the brow has a line of hair — the eyebrow — which keeps the perspiration from running into the eye.

Besides the brow, the eye is protected by a pair of fringed curtains or lids which can be drawn over the eye to shut out the light when one wishes, or to cover the eye when danger is near. The lashes help to keep dust out of the eye. If one looks at the eye (Fig. 15), he will see a round colored part with a black spot in the middle. This colored part, which is blue in some eyes, and gray, black, or brown in others, is a curtain, and the black spot is a hole through this curtain. The curtain is called the *iris*.

FIG. 15. — THE HUMAN EYE.

That dark spot which you see in the eye is an opening into a dark hole, and through that opening the light passes to the inside of the eye. The dark opening is called the *pupil*.

This opening can be made large or small.

When one looks at a bright light or at a very near object, it grows smaller; and when one goes into a dark place, it opens as wide as it can to let in all the light there is.

In the section you can see this opening and also see that over it is an outer covering (Fig. 14, *i*). This covering is as clear as glass. At the back of the eye may be seen the nerve which carries the messages to the brain (Fig. 14, *k*).

Without this nerve we could really see nothing, for, although the picture might be taken by the eye, we could not see it unless the brain could get the message.

So much of our knowledge and our happiness depends upon our sight that we should value and take the greatest care of our eyes. It does not pay to read when there is not a good light, and to overwork the eyes, for the sake of a little pleasure just at the time.

In reading by lamplight, care should be taken to sit with the back to the light or to hold the book so that the light is not reflected from the page directly into the eyes. Never read while lying down.

Some eyes are nearsighted, that is, they can

see only near objects clearly; and some are far-sighted, that is, they can see far away objects with less effort than they can see near ones.

Children who have defects of the eyes should wear spectacles, for, if they do not, they may have headache and become irritable, and make the eyes still worse by trying to make them do, alone, work for which they need the help of glasses.

To look directly at the sun or any bright light hurts the eyes, and if done too often or too long may seriously injure them.

Several forms of eye trouble, commonly called "sore eyes," come from uncleanliness, and are "contagious" or "catching." For this reason it is never safe to wash in a public washbasin or to wipe on a towel that others have used. It is better for every pupil in school to have his own towel.

One should never touch the eyes with fingers that are not absolutely clean. Earth soil has been known to cause serious eye trouble. Catarrh, and straining the eye, as for instance going without glasses when the eye needs their aid, sometimes cause painful swellings on the eyelid.

Diseases of the eye are also sometimes caused by overwork, poor or insufficient food, cough, strain, or the use of alcoholic liquors. Alcohol and tobacco cause dimness of vision.

The use of tobacco may seriously injure the sight.

THINGS TO FIND OUT

Watch the pupil of the eye of a person who sits facing a window. Shade his eyes and then suddenly withdraw the shade or let him close them and suddenly open them. Does the pupil change in size? If so, what is the change?

Look at a dog's eyes. What is the shape of his pupils?

What is the shape of the pupil of a cat's eye? Of a horse's eye?

Why do the eyes of a cat look so fiery red in the dark?

How is it that an owl can see when it is too dark for a person to see?

Why does the bright sunlight hurt the eyes of an owl?

Can a cat, or dog, or horse see better in the dark than a person can? If so, why?

HEARING

THE ear, which is the organ of hearing, is as wonderful as the eye in its structure.

That which we see on the outside is not the hearing part of the structure, it only catches the sound. But quite out of sight and reach there is a delicate set of bones and canals for taking the sound to the nerve of hearing.

Just as the eye cannot carry a picture to the brain without the nerves of sight, so with ever so good an ear one can hear nothing without the nerves of hearing.

In Figure 16 you can see how the air enters the ear, and can see where it strikes the membrane of the ear drum. Back of the drum are the coiled bony canals through which the sound is carried to the nerves.

The opening into the ear is guarded from insects by wax. Sometimes too much wax gathers in the ear, and keeps one from hearing so well, but it must never be dug out with anything smaller than the finger. A sharp-pointed thing entering the ear may do great damage. It is safe to say, never put anything into the ear.

One should always protect the ears against a strong wind blowing into them when riding, and should not sit with the ear exposed to a draught of air from open doors or windows.

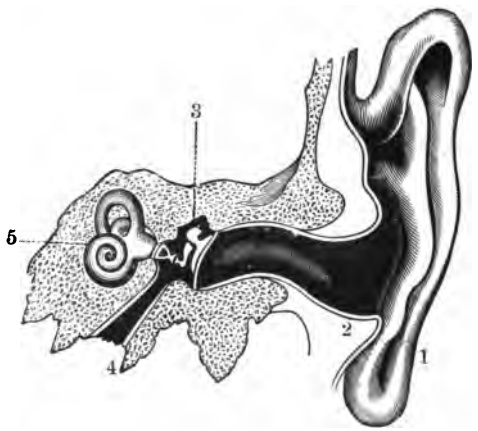


FIG. 16. — DIAGRAM OF THE PARTS OF THE EAR.

1, the outside lobe; 2, the outer opening; 3, the ear drum; 4, tube leading to the throat; 5, the coiled bony canals.

Earache in children is sometimes caused by sleeping where the head is in a draught of wind that blows into the ears.

A blow upon the ear struck sometimes in sport has injured the ear and caused deafness. Very loud noises close to the ear, like the report of cannon, gun, or pistol, or locomotive whistles, are sometimes a cause of deafness. No one in

play should strike another on the ear or make a loud noice close to the ear. A moment's sport may by such means cause a lifelong loss of hearing. Tinsmiths, blacksmiths, and other workmen who are subject to continued loud noises sometimes lose their hearing as a result. The frequent use of the telephone, if the receiver is pressed close to the ear, may cause ear trouble.

Not only the ear, but the nervous system is affected unpleasantly by too much noise. When people are very ill the physician orders the sick room to be kept very quiet, because noises make it harder for the patient to get well. But even well people are better off without noise. The rattling of carts and horses' hoofs over cobblestones, the whiz and whir and loud bells of the street cars, the cries of hucksters, the shrieks of whistles, all strike upon the brain through the ear, and have an effect similar to that of a sudden bright light before the eyes. When one is fresh in the morning he may not notice these sounds, but they help to tire him almost as much as his work, and when he is tired or not feeling well they are doubly irritating.

Some of these noises cannot be prevented; but many of them could be greatly lessened if people would only give the matter a little thought. Cobblestones could give place to asphalt pavements, iron wagon tires and iron horseshoes to rubber tires and rubber horseshoes. Many loud bells could be dispensed with, and the signals could be given with sounds that are less startling.

The dinner bell, which is supposed to be one of the most welcome of sounds, could state its message just as well in a low, clear, musical tone as in the startling noise of the gong.

Door bells, telephone bells, elevator bells could all be heard just as well if their sounds were sweet, clear, and musical as when they are stinging and rasping.

These are some of the noises which individuals could regulate for themselves. The other irritating noises of city life which one cannot prevent, he should get as far away from as possible. If one must work in the city during the day, he can select for his dwelling a house far enough out in the country to escape from the noises at night when he goes home to rest.

There are people who have harsh voices and

others who raise their voices to loud, shrill tones in speaking. For this addition to unnecessary noise no one is excusable, except a deaf person who cannot hear his own voice.

School children get in the habit of speaking in high, shrill tones by trying to make themselves heard above their playmates while at play, or while talking in groups out of school hours. More politeness in listening to one another and not interrupting while another is speaking, would to a great extent prevent the formation of this disagreeable habit of shrill speech.

A wise teacher in a large private school used to train her young ladies to cultivate pleasant voices in the following manner: —

She would send one to the highest stair at the top of the house and another to the foot of the lowest stair, or each to the opposite ends of a long corridor, and then ask each to speak so that the other could hear distinctly, but without raising the voice. In this way strong tones that could be distinctly heard were cultivated without the disagreeable sharpness that comes from high tones.

One's tone of voice may be energetic and yet

low, clear, sweet, and pleasant. Such a voice one should cultivate, both as a duty and as a means of pleasure to others.

THINGS TO FIND OUT

Why do dogs "prick up their ears" when they hear a sound which they seem to want to hear better?

CAN YOU HEAR IT?

Why do horses turn their ears backward when their driver or any one behind them speaks, and

forward when they are looking at some object ahead of them?

Why do horses, dogs, and cats resent it when one puts his finger into their ears?

Do animals hear more acutely than men?

SMELL

THE sense of smell is located in the upper part of the nose, where the nerves of smell are spread out over the lining of the nose like a fan (see Fig. 17).

This sense is much keener in lower animals than in man; many of the lower animals depend upon their sense of smell for finding their food.

Dogs that live with men have a much less keen sense of smell than wild dogs.

We hardly know how much we depend upon the sense of smell, as it is so closely linked to the sense of taste that sometimes we cannot tell which is smell and which is taste.

All the flavors which we enjoy so much in food we enjoy through the sense of smell as well as that of taste, and people who lose their sense of smell lose also a large part of their sense for flavors.

The sense of smell is specially useful in detecting foul air that might make us ill if we breathed it.

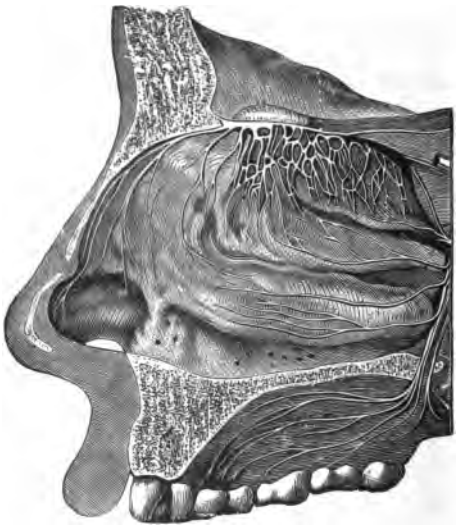


FIG. 17. — THE ORGAN OF SMELL.

Showing the many branches of the nerve of smell.
This figure shows the nerves well, but it does not show the folds which increase so much the surface of membrane, and through that increase the acuteness of smell.

The sense of smell is impaired by colds, and may be nearly destroyed by catarrh. For this, as well as for other reasons, we should strengthen our bodies against the liability of taking cold as much as possible, by means of cold baths, proper diet, and breathing pure air.

THINGS TO FIND OUT

Notice how an animal smells by holding out to it some object with which it is not familiar. Notice it "sniff" the object. What is "sniffing," and how can that improve the acuteness of the sensation?

SOMETHING IN THE WIND.

Why can one smell things better when the wind is blowing from the odorous object to the observer?

What is odor, and how can it be carried by the wind? Can an object finally be consumed by constantly smelling of it?

TASTE

THE sense of taste lies in the tongue.

The top of the tongue, as you can see, is rough. This roughness is caused by many little points, in each one of which there are nerve endings (see Fig. 18). These nerves go to form large nerves, which in time form a larger nerve which goes to the brain.

In order to taste any substance, little particles of it must be dissolved in the saliva, for only thus can it come in contact with the nerves of taste.

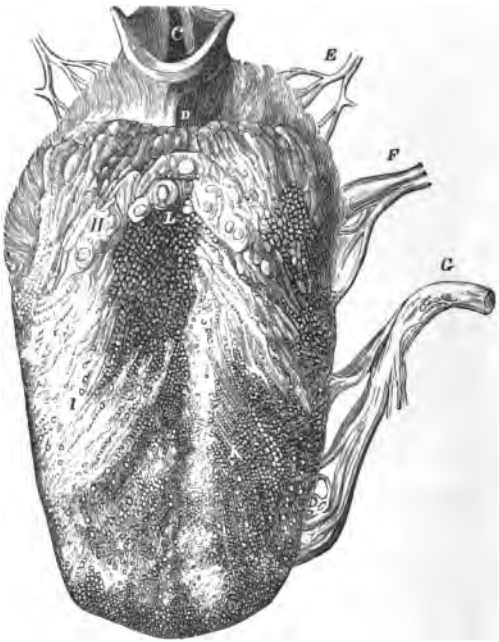


FIG. 18. — THE UPPER SURFACE OF THE TONGUE.

Showing the roughness (*papillæ*) at *I* and *K*. At *H* and *L* there are very large papillæ that look like little warts. Beyond the root of the tongue (*D*) notice the epiglottis (*C*). *E*, *F*, and *G* represent nerves which lie in the flesh below the tongue.

The sense of taste may be dulled, and thus made of less service, by the frequent or habitual use of strong, hot spices and seasonings.

As explained above, many of the sensations which are called taste are really flavors; that is, they are sensations which depend upon both smell and taste. Eat a piece of apple or a piece of turnip while holding the nose tightly. Notice that the sensation is very different from what it is usually. In this experiment one gets the taste only, and not the flavor at all. The taste of these two substances may be quite similar, while the flavor is very different.

The senses of smell and taste are like the watchmen in the town, — they decide whether or not a thing ought to come in. They send word at once to the brain if a thing, so far as they can tell, is unfit to eat.

Without these guards we might eat many things which would weaken our stomachs and make us sick.

Put a spoonful of salt into a pint of water. After the salt is dissolved, put a teaspoonful of the solution into nine of water, and see if you can taste it. If so, put one of this strength into nine of water, and see if you can taste the salt. How dilute a solution of salt can you taste?

TOUCH

THE sense of touch is given by some of the nerves of the skin. By this sense we can tell the shape of objects and whether they are smooth or rough. The nerves of touch are most sensitive on the finger tips and lips. The nerves of the skin also give us the sense of heat or cold and the sense of pain.

Persons who are so unfortunate as to lose the sense of sight are obliged to depend largely upon the sense of touch to guide them when they are going about the house or along the street.

If they learn to read, — and many of them do, if they become blind early in life, — it is by use of the sense of touch. The books which they use are printed with raised characters, and they read by moving the fingers along the lines much as we glance along the lines with our eyes.

The sense of touch may be trained to aid in the formation of cleanly habits. If we touch anything that is soiled and sticky, the brain is instantly made aware of it, and with one who is accustomed to keep his hands clean the mind is not at ease until the hands are washed.

If it is not possible to wash the hands at once, then one should remember that he must not put his fingers to his mouth, or upon anything that is to be eaten, until he has washed

How Much can You tell by Touch?

his hands. In fact, one should never touch food, nor his mouth, nor his eyes, without first washing his hands. Germs of disease are very common in the air. They are carried about with the dust of the air, and there may be some upon almost any object we touch. When we go about in public places we touch doors, railings,

and various other objects which uncleanly persons have handled.

A soldier was once seen eating a banana in a way that could easily have given him typhoid fever. He entered a railroad car with a valise in one hand and half a dozen bananas in the other. As soon as he was seated he broke off a banana, stripped the skin entirely off and threw it out of the window, and then held the bare fruit in his unwashed hand while he ate it. If he had realized how much dirt he had probably collected on his fingers from the various objects his hands had touched since last he washed them, he would undoubtedly have held the banana with the skin on, stripping it down only as fast as he ate.

It is true that one may take into the mouth germs of disease without being made ill by them, because when one is entirely well he is prepared to resist the work of such germs. But when one is very tired or faint from want of food, or is not feeling well, disease germs may get a footing before the system is strong enough to combat them.

For this reason the sense of touch should be

trained to remind us of the washbasin and towel whenever we are to use our hands in a way that could bring disease germs into the body.

EXPERIMENTS

Every boy or girl knows what tendrils are, and knows that grape vines and pea vines climb by means of them. Find a tender, open tendril which has not yet found anything to which to cling. Place a stick beside it in such a way as just to touch it near its tip, and visit it several times a day to see what it does. When you have found out all you can about it, write an essay about "Tendrils and what they do." Perhaps you can think of experiments other than the one described above.

Let one member of the class be blindfolded and tested with various objects to see how much he can tell about them. Why can he not tell the color?

ALCOHOL AND THE SENSES

We have seen how necessary our senses are and how helpless we should be without them. We shall do well to remember that the use of alcoholic drinks makes all of the senses less acute.

There was once a time when men used to take wine or brandy or some other alcoholic drink when they had anything difficult to do, that is, when they had on hand some piece of work which required all of their senses to be alert and all of their powers active.

One of the curious things about alcohol is that it makes men think that they can see and hear better and that they are quicker in their movements. As soon as physicians began to experiment with alcohol, it was found out that a person cannot see or hear so clearly or act so precisely after he has taken a little alcohol as he could before. But in spite of this fact, the person always thinks that his senses and his movements are improved.

So, for hundreds of years, men have been fooled by alcohol. They have taken it to keep them warm in winter, when it really cools the body; they have taken it to make them cool in summer, when it makes them more liable to be overcome by heat; they have taken it to make them strong, when it really makes them less strong; and they have taken it to make their senses more acute, their movements more pre-

cise, and their brains more active, when it really dulls all of the senses and makes the brain less acute and the muscles less accurate and enduring.

HOW WE THINK AND WHAT WE THINK WITH

Do you remember that in the town which we looked upon, there was a central telephone station from which messages were sent all over the town and to which messages were coming from all parts?

We have in our bodies something very much like this central station, with its many nerves like the wires running in every direction to carry messages to and from every part of the body.

The brain is the center of all our thinking. It directs all of our motions and regulates our senses.

In the picture (Fig. 19) you can see the two parts of the brain and the nerves that run from the brain to the other parts of the body. The nerves carry the messages. There is a large bundle of nerves which passes down the back. This is the spinal cord.

From the spinal cord, branches are sent out to the arms and legs. All of these nerves branch and branch again until every part of the body is supplied with nerves.

FIG. 19. — THE BRAIN, SPINAL CORD, AND LARGE NERVES.

The nerves that carry messages of seeing, hearing, smelling, tasting, feeling, to the brain are called the *Nerves of Sense*, but those that carry messages from the brain to tell the muscles when to contract or relax are called *Nerves of Motion*.

Try touching your body with the point of a needle, and see if you can put it anywhere where you will not feel it.

This wonderful system of nerves is all the time sending messages to the brain to keep it informed of everything that is being done in the body. When the finger touches anything hot, the nerves

send the thought "hot" directly to the brain or to one of the nearer nerve centers, and the brain sends a message back to "take the fingers away."

When we eat, the nerves in the mouth send word to the brain as to the taste, the nerves of the nose send word about the smell, and so on.

When the eye sees something falling near us, the word is sent to the brain, "danger," and the message comes back to the muscles of the legs, or arms, telling them what to do to escape it.

When the ear hears something coming upon us, the word goes to the brain and we are told to get out of the way.

In this way messages much like the telephone messages are flying along the nerves all of the time.

If any of the nerves become diseased, they cease to do their work well. For example, if the nerves of the eye are injured, one sees less clearly or perhaps becomes blind because the nerves of sight do not send messages to the brain. If the nerves of feeling become diseased, they may feel too little and not warn one of danger.

If the nerves of motion are diseased, one may move when he does not wish to, — that is, the head

or some other part of the body will shake. Or he is unable to move some part of the body when he wishes to do so. This condition is called paralysis.

You see how important it is that the brain and all the nerves should be kept in the best possible order, and as they are very delicate they need very good care.

If you look again at Figure 19 you will notice that the upper and larger part of the brain has a folded surface. This part of the brain is called the *cerebrum*. Just below the back part of the cerebrum is the small and nearly smooth *cerebellum*.

The cerebrum is the organ of thought. With it we feel pain or pleasure, sorrow or joy. With it we reason, and we decide or will to do certain acts or to speak certain words.

The cerebellum receives and sends out messages, but we are not conscious of them; that is, we do not know what the messages are. This part of the brain helps us to balance ourselves when we walk, skate, or ride a bicycle. The cerebellum also presides over the action of muscles, making the muscles of the arm, for example, work harmoniously and gracefully. When one decides to reach for a certain object one does not think just how

much each muscle must contract to do what we wish. It is the cerebellum that performs all of these details.

EDUCATION

THE cerebrum, the cerebellum, and the spinal cord may all be educated; that is, they may all be taught to do their work better. The cerebrum may be taught to feel more acutely the messages which are brought to it from the eyes, the ears, the tongue, the nose, and the skin; it may be taught to think more clearly about the feelings or sensations brought to it by the nerves of sense; and it may be taught to decide more quickly what is the best thing to do or to say under different circumstances.

To educate the brain to feel more acutely and accurately, it is necessary to look at or listen to *only one thing at a time.* In other words, to give one's whole *attention* to one thing at a time.

To educate the brain to think more clearly, it is necessary that one *think of only one thing at a time.*

To educate the brain to decide questions, or to *reason,* three things are necessary: (1) *attention* to

the things we see, or hear, or smell, or taste, or feel; (2) *clear thinking* about the things we see and hear; and, finally, (3) the working of various problems — problems in arithmetic, problems in geography, problems in language, and problems in physiology.

UNDIVIDED ATTENTION.

The playing of games is a very important part of an education. Under games one may include all of the games of the kindergarten, marching to orders given by the teacher or a drillmaster, and all lawn or floor games where one person or one group contests for points against another person or group — baseball, football, tennis, croquet, prisoner's base, archery, quoit-pitching, bowling, etc. All of these games require a person to *fix the attention upon one thing*, to *think quickly and clearly*, and to *decide rightly*. The systematic playing of

properly chosen games is as important as any other part of the education, and if neglected puts one at a disadvantage throughout life.

The best health of the nervous system requires a state of quiet and peacefulness. The feelings of anger, displeasure or irritation are unhealthful.

If some act of another person displeases us, we are doing ourselves an injury to permit a feeling of irritation to take possession of us. It is as bad for the nerves as a drink of pepper tea would be for the stomach. The person who cherishes kindly feelings toward others benefits himself as much as the person to whom he shows the kindness.

THINGS TO FIND OUT

Describe the messages that go to and from the brain if a thunder shower comes up when one is without an umbrella a short distance from home.

What would be the result if no such messages could be sent?

What is the central station in the body for sending and receiving messages?

What happens when the central station is not in a condition to receive or to send out messages properly?

What is necessary before a new telephone operator at a central station can become expert in changing the wires and making connections?

What are some of the "connections" that must be made in the brain if one has to get ready at short notice to take a long railroad journey?

What are some of the "connections" a farmer must make in putting up, taking to market, and selling at a profit, a load of garden produce?

What is necessary to make the mind quick, accurate, and skillful in planning and carrying out the ordinary work of life?

SLEEP

Every part of the body needs rest at some time. After you have thought of that a little while you will say, "But the lungs and heart never rest." Are you sure?

Notice your breathing for a little while. When the breath is drawn in, the diaphragm and the muscles of the chest work; but the air flows out without requiring any effort, so the breathing muscles *rest during expiration.* In this way, while the lungs always keep us supplied with air, they rest a part of the time.

The heart, too, works night and day, but after each beat there is a pause during which the heart rests.

These are the only organs that have to work day and night, and all the rest of the body depends upon the sleeping time for its rest.

The body would very quickly wear out without this needed rest. As long as a person is awake the nerves are at work and the brain is busy thinking. Not only does the body need rest after a day's work, but the brain needs it quite as much.

Although one is asleep, some parts of the brain may go on working, and then one has dreams.

Grown people need seven to eight hours of sleep in every twenty-four, but children, who use so much strength in growing, need more sleep than that, and the best time for sleep is the early part of the night. Any one who wishes to do the best thinking, the best working, and to excel in the school games, must go to bed early and have restful sleep.

FAST ASLEEP.

Let us see how we can get the best rest from our sleep. We have already said that there must be pure air in the sleeping room. After sleeping in a poorly aired room one is likely to waken with a headache or to feel cross when he first gets up, and that is a poor way to begin the day.

Sleeping with the mouth open is a very bad habit, and may lead to disease of the throat and lungs.

Eating rich food or much food of any kind just before sleeping disturbs the sleep, because the stomach has to keep on working. If it

WIDE AWAKE.

becomes distressed in any way, it sends messages to the brain so that it cannot rest, and one has bad dreams.

The covering of the bed should be just enough to keep one warm; too much covering weakens one and makes him feel listless in the morning.

When one wakens naturally from a good refreshing sleep, it is usually time to get up, and it does more harm than good to lie in bed after that time.

Let us review this lesson a moment: —

Go to bed early.

Breathe pure air.

Breathe through the nose.

Do not eat rich food just before going to bed.

Sleep under light covering.

Get up when you waken.

SOME ENEMIES OF THE BODY

If the people in our town knew that just outside of the town were enemies who would spoil their telephone system that had been made so carefully to meet every need of the town; would weaken their policemen so that they would no longer guard the city so faithfully; would tamper with the food so that it would not be so healthful; would even rob the people of their appetite for food; and would take away their wish to improve the town, — do you think they would sit quietly down and say, "Let them

come in, we can put them out easily if we do not want them." Or, worse than that, would the people invite them in, saying, "Perhaps they will not hurt our town so much as they have hurt other towns they have entered."

Alcohol and tobacco are the enemies that will do for the body what these enemies would do for a town. Your nervous system is much more delicate than a city telephone system. *Alcohol and tobacco are narcotics and dull the senses.* They irritate the lining of the stomach, but at the same time dull the sense of feeling so that the nerves of the stomach do not send word to the brain of the trouble there, and the one who has used the alcohol does not know of the harm being done.

If on a cold day one should take an alcoholic drink, his nerves would not tell him how cold it is, and the brain would send no word of warning that would lead him to protect himself or keep him from freezing. Drinking men are much more easily affected by the cold than are other men.

Not only the nerves, but the great nerve center, the brain, is injured by alcohol and by

tobacco too. A person who has been drinking much does not know what he is talking about, he says foolish things, he does not know what he is doing, and does many things of which he is ashamed when sober. When a man's mind cannot control his talking or his acting there must be something wrong with it. You may think that this bad effect lasts only so long as the man is drunk, but that is not so. Each time that the brain is affected it becomes weaker, until after a time, even though the man may now use no alcohol at all, he cannot think so well as he used to think before he began the use of alcohol.

Tobacco has a terrible effect upon the brain and nerves of a young person. So clearly do people realize this bad effect of tobacco that more than half the states in the Union have made laws to keep people from selling any form of tobacco to boys.

Boys sometimes think that cigars are bad, but think no harm can come from so small a thing as a cigarette. That is a great mistake. Through cigarettes alone many boys have been stunted in growth, have been made so nervous that the

hands trembled, and have weakened their brain power until they could no longer keep up with their grades at school. In many instances, too, these were boys who before using cigarettes led their classes.

A Steady Nerve.

How the story of William Tell thrills us! All the world admires such a cool head and such steady nerves. The picture shows the proud and tyrannical Gessler demanding of Tell what he intended to do with the second arrow. Such a test as that may never again be made of a

man, but other crises come in the life of every person. When these tests come one needs to have a clear eye, a steady hand, and a power of quick decision and strong action. The men who possess all of these qualities are the men who succeed in life, while the men who do not possess them either fail completely or make a less marked success than they could have made with all of their faculties trained and alert. When we know what alcohol does for the senses and the brain and muscles, it seems strange that people should ever touch a drop of it.

The white corpuscles that guard the body from harm are very much weakened by the use of alcohol, so much so that they cannot drive off disease so well as they can when healthy, and therefore drinking men take disease much more quickly than others do.

Some of the largest insurance companies will no longer insure men who drink at all, just because statistics show that such men take disease more quickly.

Many large railway companies will not employ men who are known to use alcohol even in small amounts.

WHAT DOCTORS AND TEACHERS SAY ABOUT THE USE OF TOBACCO

"A CERTAIN doctor, struck with the large number of boys under fifteen years of age whom he observed smoking, was led to inquire into the effect the habit had upon their general health. He took for this purpose thirty-eight boys, aged from nine to fifteen years, and carefully examined them, and in twenty-seven of them he discovered injurious traces of the habit. In twenty-two there were various disorders of the circulation and digestion, palpitation of the heart, and more or less marked taste for strong drink. In twelve there was frequent bleeding of the nose; ten had disturbed sleep; and twelve had slight ulceration of the mucous membrane of the mouth, which disappeared on ceasing from the use of tobacco for some days. Medical treatment was of little use till the smoking was discontinued, when health and strength were soon restored." — *British Medical Journal.*

"The use of tobacco in any form previous to sixteen years of age has an undoubted tendency to lower very materially the mental force and

acumen, and to render the user a person without ambition, and may even cause insanity or idiocy." —N. B. DELAMATER, M. D., *Specialist in Mental and Nervous Diseases.*

"In over twenty years of experience as a teacher I cannot recall a single boy who maintained a high average in his classes and used tobacco, and further, some who were very bright and stood well in their classes lost their standing when they acquired the tobacco habit." —JONATHAN K. TAYLOR, Baltimore, Md., *formerly Principal Taylor Academy, Wilmington, Del.*

The government of the United States of America has prohibited the use of the cigarette at West Point and Annapolis, on sanitary and moral grounds. Many colleges prohibit its use. Dr. J. W. Seaver of Yale College says, "Out of our highest scholarship men only a very small percentage (about five) use tobacco, while of the men who do not get appointments, over sixty per cent are tobacco users."

James E. Armstrong, Englewood High School and President of Board of Trustees of University of Illinois, said: "There are few cigarette smokers in the high school. Smokers usually fail to go

through the grammar school. Few ever graduate who smoke before they enter the high school. As a rule the smoker is dull and unable to concentrate his attention upon his work. It is difficult to arouse him to any degree of enthusiasm. So long as men indulge in smoking it will be hard to persuade the boys that they should shun it, and so long as boys continue to learn the habit there will be men to perpetuate it."

You may sometimes hear people say that there is no harm in drinking a little wine or beer, or in smoking or chewing tobacco "a little," if one does not take "too much." They will tell you that one should have such a strong will and such self-control that he will be able to stop when he has taken only a little. This would be true if alcohol and tobacco acted upon the body as food does, simply making us ill when we take too much. But these substances, alcohol, tobacco, opium, and other narcotics, affect the mind in such a way as to weaken that very self-control that is needed to keep one from taking more than a little. Great men of science have found by careful and ingenious tests that one of the first effects of only a little

alcohol in the body is to weaken the power of self-control. No one can tell, therefore, when he takes the first little how much more he may be led into taking.

THE BODY FRAMEWORK

If the entire body were as soft as the organs about which we have already studied, the body would lie all in a heap together and we could neither stand nor walk.

A body that could not stand nor walk could do very little in the world. There are some animals that are in this condition, but they belong to a very low order of animals.

We have within us a strong, hard framework that gives support to the entire body. The backbone, the hip bones, the leg bones, and the shoulder and arm bones support the entire body. By pressing upon different parts of your body you can feel some of the bones of this framework.

You need not be told how bones look, for every child has seen bones, if not the bones of a person, certainly the bones of chickens, cows, and sheep, and all bones look a good deal alike. That is, they are hard and white on the outside.

The hardness is given to the bones by lime, but there is also a jellylike part, which, when boiled out, makes gelatine. If the long bones of the body were solid, they would be very heavy to carry around, but they are hollow, and this hollow part is filled with a soft, fatty substance called marrow (Fig. 20).

FIG. 20. — A PART OF THE THIGH BONE. Showing the hollow part (*h*), which is filled with marrow.

You have seen the marrow of a soup bone, perhaps, and have noticed the yellowish color it has. The blood vessels come up through the marrow and in tiny openings in the bone, bringing the food that makes the bones grow. The blood flows even through the bones.

In a little baby the bones have more of the gelatine matter than they have of lime, and they are, therefore, soft and easily bent.

Even half-grown children have softer bones than grown people, and that is why they can tumble about so much without breaking their bones. It is also the reason why children must

be careful to stand straight and sit straight. The bones, being soft, will readily take a position and will then grow in that way.

Sometimes school children sit low in their seats, bending the back instead of sitting erect (see Fig. 21); or sit with one arm upon the desk, raising one shoulder higher than the other; both of these and similar habits cause a curving of the back-bone.

If you wish to add strength to your bones, you must have lime in some way. Do you remember

FIG. 21. — IMPROPER AND PROPER POSITIONS IN SITTING.

which foods are best for furnishing to the bones the lime which they need while they are growing?

Pure air and sunlight are also necessary to healthy growth of the bones.

The muscles are all fastened in some way to the framework or skeleton; without this support they could not hold tight enough to lift the legs and arms and turn the body. If you have the leg bone of a chicken or sheep to look at, perhaps you can find upon the bone the ridges to which the muscles were fastened.

THE SKELETON

I. JOINTS

THE skeleton is not all in one piece. If it were we could not bend, could not pick up things with our fingers, could not eat, nor, indeed, do any of the work which we now do. Think how stiffly you would walk if there were no bend in your legs, and how awkward you would be with no bend in your arm. Think how little you could do with your fingers if they would not bend.

The bones are of very different lengths, joined

together in such a way that the ends can move. The place where the bones come together is called a *joint.*

FIG. 22. — HINGE JOINT OF THE ELBOW.

1, humerus; 2, ulna.

Some of the joints bend back and forth like the hinge on the door (Fig. 22), while others bend in any direction. The first kind are the *hinge joints*, and the second kind the *ball and socket joints* (Fig. 23). Can you find in your body one or more of each kind?

Bones are not all of the same shape, by any means, but are long or short, flat (see Fig. 24) or round, according to the work they have to do.

FIG. 23. — A JOINT THAT TURNS IN ANY DIRECTION — THE HIP JOINT.

This is a ball and socket joint.

FIG. 24. — A FLAT BONE — THE SHOULDER BLADE.

II. BONES FOR PROTECTION

Bones have two special uses: (1) to support the body; and (2) to protect the delicate parts. Most of the bones which are used for support are round and long, while many of those that protect are flat. There are some parts of the body that are so soft and delicate that a fall or a blow upon them would crush them.

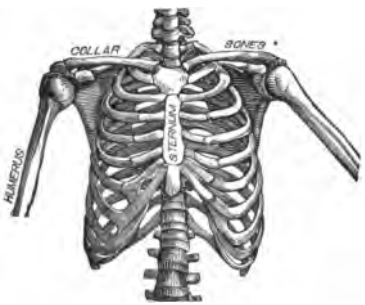


FIG. 25.—THE RIBS AS THEY OUGHT TO BE.

These delicate organs all need some hard covering that will neither crush nor break easily, and, as usual in nature, where there is a need there is also a supply. The bones are so arranged as to form this protection.

If you look at the picture (Fig. 25), you can see the rib bones extending out from the backbone, and joining the breast bone, thus making a space in which the lungs and heart can be safely stored and protected. The lower ribs extend down far enough to cover the liver and stomach.

There is just one organ more delicate than those of which we have spoken, and that is the brain, and for this organ there has been made a

FIG. 26. — SIDE VIEW OF THE SKULL. Showing the most important bones of the skull, and their names.

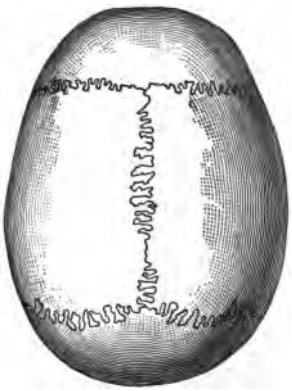


FIG. 27. — TOP VIEW OF THE SKULL. Showing the crooked seams or sutures where the bones are joined.

boxlike covering that protects it on every side. Look at the picture (Fig. 26), and you will see how the bones are put together to form a somewhat spherical box in which the brain lies.

This box is not all of one piece, but is formed of eight beautifully fitted bones whose edges fit together like two saw-tooth edges, as shown in Figure 27.

EFFECT OF ALCOHOL AND TOBACCO UPON THE BONES

EVERY boy wishes to grow into a large and strong man. Physicians who have made a study

A FINE FIGURE.

of the things which help or hinder the growth of children and youths agree that the use of tobacco and alcohol, also of strong tea and coffee, injure young people and hinder their proper growth and development. If a boy becomes a soldier he

wants to stand near the head of the company among the tall men; if he represents his school or college on an athletic team he wants strong legs and arms and long legs and arms. The length of the legs and arms as well as the height of the body depends upon the growth of the bones. Boys and girls and youths who use alcoholic drinks or other narcotics cannot grow into so large or so strong men and women as they could if they used the foods and drinks which are intended by nature for use.

Name the principal articles of a natural diet for mankind.

Name some of the things that must be avoided if one would have a fine, strong, properly shaped body.

THE FRAMEWORK OF OTHER ANIMALS

THERE are animals lower than man that have skeletons almost like ours (see Fig. 28). At first thought a cat seems to be a very different shape from a baby, and yet both have about the same number and kinds of bones of about the same shape.

The cat, dog, cow, horse, pig, and all such animals use all four limbs for walking, while we use only our hind limbs for walking and

Elk Giraffe Elephant Lion Man

FIG. 28. — SKELETONS OF BACK-BONED ANIMALS.

Look for the elbows of all the animals. Look for the knees; the wrists; the ankles; the heels.

our front ones for lifting, carrying, and other such work.

The body of the bird seems still less like ours than does that of the sheep or the cow, and yet when the feathers are off we find the bird has

just about the same kind of a framework as we have. The bird uses the hind limbs for walking and the front ones for flying. Even the frog skeleton is in a general way like your own (Fig. 29).

The foot of a horse or cow or sheep does not look at all like your own foot, and yet if you look at the picture (Fig. 30), and compare it with the

FIG. 29.—SKELETON OF THE COMMON FROG.

FIG. 30. — BONES OF HUMAN LEG AND FOOT, AND MUSCLES OF CALF.

leg and foot of the lion or elk, you will see that it is not so much the bones that are different, as the way in which they are used.

The cow walks on her toes and keeps her heel in the air, while we keep ours down on the ground. The middle joint on a cow's hind leg corresponds to the heel, and the middle joint on her front leg to the wrist. The horse walks on his middle toe, and in this way seems to have a

foot with a hoof and no toes or nails; but the horse's hoofs and the hoofs of all animals correspond to our finger nails and toe nails.

The joint on the horse's fore limb that looks like his knee is really his wrist joint, and the

FIG. 31. — HORSE.

one higher is the elbow joint, while the hip and shoulder joints are quite out of sight (Fig. 31).

The turtle, whose body at first thought seems to be quite unlike our own bodies, when looked at without his shell and his muscles, is found to have a skeleton very little different from ours.

HOW THE BODY MOVES

We have learned that the nerves send word to any part of the body to tell it to move, and that the bones are so made that they can move, but nothing has yet been said of the muscles which give us the power of motion.

Lean beef is the muscle of the ox, lean pork the muscle of the pig. Our muscle looks much the same as beef muscle before it is cooked.

Muscles are made of many bundles of fibers or threads fastened together by a web as thin as tissue paper. In meat that has been well boiled, these fibers can be easily pulled apart; sometimes they even fall apart.

Muscle fibers are bound together in many sizes and shapes to fit the work they have to do. The muscles of the eye are very small indeed, while the muscles of the legs are long and large.

If you take a piece of rubber and stretch it, you will find that it grows longer and thinner at the same time, and when you let go it draws quickly back again to its first size. The muscles are able to tighten up or contract, becoming

shorter and thicker, and then to relax or go back to their first size.

This power of the muscle to contract and relax is the power that moves the body.

With your left hand take hold of your right upper arm, and then bend your right arm up

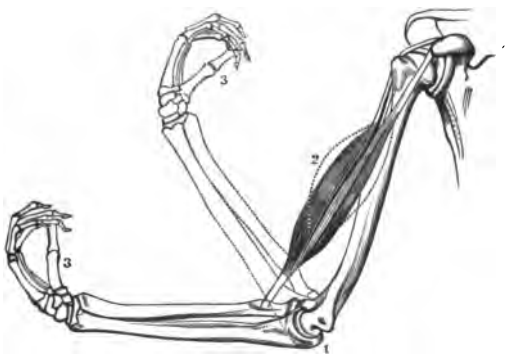


FIG. 32.—DIAGRAM TO SHOW THE ACTION OF THE BICEPS MUSCLE OF THE ARM.

to the shoulder; can you not feel the muscle under your hand getting thicker? (See Fig. 32.)

The muscle on the upper arm is fastened to the shoulder and to the fore arm just below the elbow. When that muscle gets shorter or contracts, the arm must come up, and when the muscle gets longer again, or relaxes, the arm must go down.

Shut your fist up tightly and look at your

wrist. Do you see those strong cords? (Fig. 33.) They are joined to the ends of the muscles and fasten them to the bones. The cords and tendons are not at all elastic, and they hold on to the bones so tightly that they must move when the muscles pull on the tendons.

FIG. 33. — THE MUSCLES AND TENDONS OF THE LOWER ARM.

Showing also the ligament encircling the wrist.

If you can get a chicken's or turkey's foot and leg, you can cut open the yellow, scaly skin of the leg and you can see the heavy white tendons, and by pulling them find out what part of the foot is moved by them.

The stronger and larger a muscle is the more it can move or lift. The size and strength of the muscles may be increased by using them.

If a person wants to be strong enough to lift heavy weights, to take long walks, to run fast, to row and swim, he must use his muscles a little each day at first, and then more and more each day until he becomes strong.

The muscles have to be fed enough good blood to enable them to make all the motions of the

RUNNING IS GOOD EXERCISE.

body, and to give all the heat needed to keep the body warm.

THE CARE OF THE MUSCLES

BY this time you are all sure of one thing, and that is the need for good food and the wastefulness of eating things simply because they taste good.

We, of course, want our food to taste good, but food that only tastes good and does not nourish makes the body a great deal of work, which simply helps to wear it out without helping to build it up.

There are some things which people get into the habit of eating and drinking which do them no good at all, and others still that do them real harm; but yet they are taken because they leave a pleasant feeling.

If it is foolish to take food or drink that does no good, is it not still more foolish to take that which does harm?

The fat of the body cannot contract or relax as the muscles can, and therefore it has no strength and no power of motion.

If a boy or man wishes to be strong, he must build up muscle and not fat. Fat is nature's way of laying aside material that it cannot use. A good deal of fat often, but not always, shows that a person is eating too much.

Beer, wine, and cider often tend to change the muscles to fat and weaken them very much. Sometimes the fat collects around the muscles and crowds them so that they become weak.

Men who drink beer often become fat and look very heavy, but they are not so strong as they would have been without the beer.

When men or boys are training to do some feat of skill which needs steady nerves and strong

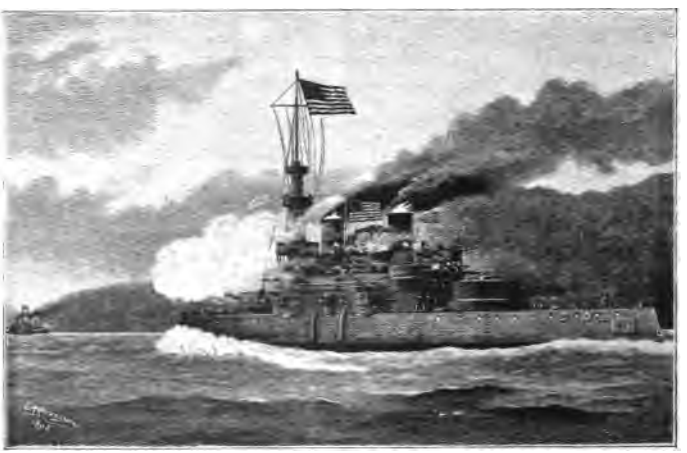
muscles, they are not allowed to use anything that has alcohol in it, nor are they allowed to use tobacco. Football teams, track teams, men who are to win the boat races and foot races for schools and colleges, are not allowed by their trainers to use beer, wine, or cider, or any drink that contains alcohol. They are not allowed to use tobacco, or even strong tea and coffee.

Governments are learning that soldiers cannot march so long, or stand the hardships of war so well, when they have had alcoholic drinks; and in Germany, France, and England they no longer give alcohol to the soldiers when there is fighting or hard marching to be done.

It used to be a general custom on board of war ships to serve out alcoholic liquors to the men just before a battle to "give them courage." This custom is no longer followed in the American navy, and the folly of the custom was very clearly shown at the battle of Santiago in the recent Spanish-American war.

Just before the Spanish fleet sailed out of the harbor to run past the American vessels, wine and other alcoholic liquors were served out to the Spanish sailors. On the American vessels no

liquor was served, but every man at the given signal stood at his gun with clear brain and steady nerves. The result was that the Spanish gunners fired wildly and their shots were without effect, while the American gunners fired true to the mark and not a Spanish vessel escaped.



THE OREGON IN THE BATTLE OF SANTIAGO.

Tobacco makes the muscles weak and soft. Have you noticed how boys who smoke cigarettes like to lounge about and lean on something? Did you ever see a boy smoker walking briskly and looking as energetic as the boy who never smoked? Men smokers sometimes do, but boys

are using so much energy in growing that they cannot afford to lose any by smoking.

The heart is largely made of muscles, and anything that affects the muscles affects the heart. The tobacco that weakens the other muscles also weakens the heart. If part of the muscles of the heart are changed to fat by alcohol, they become too weak to send the blood over the body with force, and some or many parts of the body will suffer.

EXERCISE

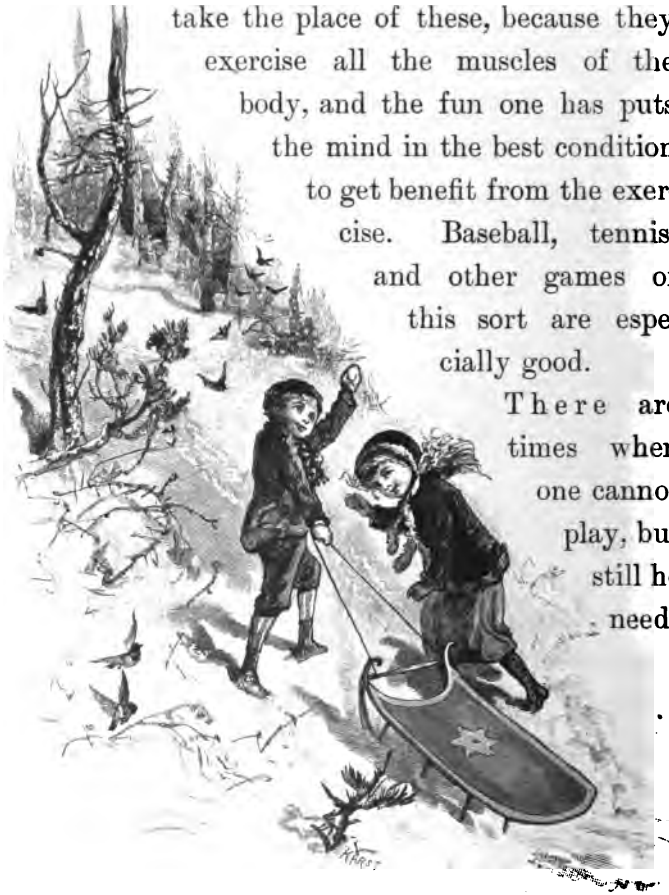
THE child, or, indeed, the man, who wishes to be strong, must use his muscles.

Why is it that one person can walk five or ten miles without being tired, while another cannot walk one mile without being tired?

It may be any one of several reasons. The person who cannot walk well may have too much fat instead of muscle, or his lungs may not be able to take in air enough for brisk exercise, or he may be sick in some other way; but it is much more likely to be that he has not used his walking muscles. If we want to be strong in a particular way, we must exercise the muscles that do that kind of

work; and to be strong all over we must exercise all the muscles.

The very best way of exercising is through out-of-door games. There is nothing else that will take the place of these, because they exercise all the muscles of the body, and the fun one has puts the mind in the best condition to get benefit from the exercise. Baseball, tennis, and other games of this sort are especially good.



There are times when one cannot play, but still he needs

exercise just the same, and then some other kind must be used. The kind of exercise that makes the muscles strong is the kind that begins easily and lightly and gradually grows harder.

Light dumb-bells and wands and light Indian clubs are much better for children than heavy weights and large Indian clubs that tax the strength. Before beginning an exercise care should be taken to let in plenty of pure air, because the muscles cannot do their work properly without this.

The more the muscles act the more food they need, so that we should not choose for our exercise a time when we are hungry nor just after a meal. If we are hungry, the call for so much food for the muscles makes a drain on some other part of the body; and when we have just eaten, the stomach needs the blood to digest the food, and if it is taken off by the muscles one may suffer some pain from indigestion.

In playing and other kinds of exercise care must be taken to stop before one is too tired.

People sometimes seem to think that only boys need exercise, and that girls will be strong enough without, or that girls do not need to be strong.

That is a mistake; for the muscles of a girl are just like the muscles of a boy, and need to be used if they are to be strong, and need to be strong if the girls are to be well.

HOW TOBACCO AFFECTS MUSCULAR EXERCISE AND GROWTH

TOBACCO AND ATHLETICS

Professor J. W. Seaver of Yale University says: "Every schoolboy knows that when athletes are in training for a contest they are obliged to abstain absolutely from all forms of tobacco. Is this done on theoretical or on moral grounds? Not at all. It is done because experience of many decades shows that when men use tobacco they cannot do as well as they can when free from its effects. Under the influence of tobacco the young man is less alert, less steady, and has less endurance. No man, when entering a contest, will knowingly and willingly handicap himself.

"The muscle cells are also, apparently, only slightly affected by it, but, the nerve supply to

the muscles being affected, the power of motion is greatly lessened. This has been thoroughly proven by experiments carried on by Dr. W. P. Lombard of the University of Michigan, who has shown that the giving of even moderate amounts of tobacco in the form of smoke lowers the working power of the human muscle by a large percentage. His experiments were made with an instrument called the ergograph, and his results may be summed up as follows: In from five to ten minutes after beginning to smoke an ordinary cigar, muscular power began to diminish to about 25 per cent of its first value. The total work when under the influence of tobacco, compared with a similar normal period, was 24.2 to 44.8.

"Whenever it is desired to secure the highest possible working ability of the body, as in athletic contests, where the maximum of effort is demanded, all narcotic influences are removed as far as possible, tobacco being one of the first substances forbidden."

"All candidates for the crews and other athletic sports of Yale College are non-smokers." — *Medical News.*

DOES TOBACCO RETARD PHYSICAL GROWTH?

Professor Seaver of Yale University says that "the records of the students who entered Yale in nine years, when all of the young men were examined and measured, shows that the smokers averaged fifteen months older than the non-smokers, but that their size — except in weight, which was from one to three pounds more — was inferior in height to the extent of nearly one-third of an inch, and in lung capacity to the extent of over five cubic inches.

"For purposes of comparison the men composing a class in Yale have been divided into three groups. The first is made up of those who do not use tobacco in any form; the second consists of those who have used it regularly for at least a year of the college course; the third group includes the irregular users. A tabulation of the measurements of these men, through a period of three and one-half years, shows that the first group grows in weight 10.4 per cent more than the second, and 6.6 per cent more than the third. In height the first group grows 24 per cent more than the second, and 11 per

cent more than the third; in girth of chest the first group grows 26.7 per cent more than the second, and 22 per cent more than the third; in capacity of lungs the first group gains 77 per cent more than the second, and 49.5 per cent more than the third."—SEAVER on *The Effects of Nicotine.*

These results are essentially the same as those obtained by Dr. E. R. Hitchcock of Amherst College, who observed a similar group of young men in a manner entirely independent. He says: "In separating the smokers from the non-smokers, it appears that in the item of weight the non-smokers have increased 24 per cent. And in lung capacity there is a difference of 8.36 cubic inches (this is about 75 per cent) in favor of the non-smokers, which is 3 per cent of the total average lung capacity of the class."

"When the Europeans first visited New Zealand they found the natives the most finely developed and powerful men among the islands of the Pacific. Since the introduction of tobacco, for which these men developed a passionate liking, they have, from this source alone, become decimated in numbers, and so reduced in stature

and physical well-being as to be an altogether inferior type of men." — *N. Y. Medical Journal.*

"Boys who have used tobacco freely are thin, anæmic, and neurotic, and are often undersized." — GEO. H. CATTERMOLE, M.D., *Univ. of Col.*

"There is no scientific basis for any supposition that after sixteen years of age a person can use tobacco with impunity. *It is bad at all ages.* The earlier the smoker begins the worse for him, because he has a longer time in the future to injure himself. The nature of the injury is the same." — EDMUND ANDREWS, A.M., M.D., LL.D., *Professor of Surgery, Northwestern University Medical School, Chicago.*

"It is positively harmful and detrimental to the development of the physical and mental powers of our growing youth. Statistics show most markedly the contrast in physical and mental standard between the boy who uses tobacco and the one who does not." — L. D. MASON, M.D., Brooklyn, N.Y.

"I do not hesitate to say that the habitual use of cigarettes is, without question, a most pernicious practice, especially in the immature." — SHELDON LEAVITT, M.D., Chicago.

REASONS WHY THE CIGARETTE IS ESPECIALLY DANGEROUS

"Cigarette smokers almost always inhale the smoke and therefore get the harmful effects of the tobacco as found in ordinary smoking, and in addition the bad results obtained by drawing nicotine and the other parts of the smoke into the nasal passages, the pharynx, larynx, trachea [windpipe], and bronchial tubes. There are good authorities who maintain that the air cells in the upper part of both lungs are affected by the inhaled tobacco smoke.

"Again, the cigarette is bad because it is so cheap, and consequently is within the reach of boys of tender age, who obtain them in packages and smoke them almost continually during the waking hours.

"Owing to the sensitiveness of the youthful system to all drugs, this results in stunted growth, which leaves its imprint after the boy has grown to manhood, and in many, many cases the effects are never outgrown even though the cigarettes are discontinued." — Dr. Charles H. Hamilton.

"A good deal has been said about the evils of cigarette smoking, but not one half the truth has ever been told. Cigarette smoking first blunts the whole moral nature. It has an appalling effect upon the physical system as well. It first stimulates and then stupefies the nerves. It sends boys into consumption. It gives them enlargement of the heart and it sends them to the insane asylum. I am often called in to prescribe for boys for palpitation of the heart. In nine cases out of ten this is caused by the cigarette habit. I have seen bright boys turned into dunces, and straightforward, honest boys made into miserable cowards by cigarette smoking. That I am speaking the truth, nearly every physician and nearly every teacher knows." — Dr. A. Clinton of San Francisco, *Physician to several boys' schools.*

The Superintendent of West Point says that many of the students having developed eye trouble soon after entering the academy, an expert oculist examined the eyes of the students and declared that the weakness of vision was caused by tobacco poisoning from the use of cigarettes before entering West Point.

"Tobacco is used by boys mostly in the form of cigarettes — probably because of their mild taste and pleasant effect. I know one New York City boy who had spasmodic twitchings of the facial muscles as the result of the excessive use of cigarettes. This continued long after the habit was broken."—GEO. H. CATTERMOLE, M.D., *University of Colorado.*

CLOTHING

THE first thought in all clothing should be its usefulness. In warm weather it should keep us cool, in winter it should keep us warm, and all the time it should allow us to move freely, to grow naturally, and to get the best use of our organs.

To wear just what everybody else wears just because they wear it is not enough; we must do some thinking for ourselves.

If your foot is wide across the toes, pointed shoes are not meant for you, even if other people do wear them. A shoe should fit the foot. If it is so large that it slips about, or so small that it pinches, it will cause corns. The soles should be

thick enough to keep the feet dry, and to keep one from feeling every little uneven and rough place he steps upon. One can stand and walk much longer without being tired if he wears shoes with thick soles and broad low heels than he can if he wears shoes with thin soles and high heels.

The clothing should not be heavy, and the weight should hang from the shoulders. Tight bands around the waist throw all the weight upon the soft parts of the body instead of upon the bones.

Tight clothing presses upon the young bones and gets them out of shape. If the ribs are pressed in, the lungs and liver do not have room enough to do their work well (see Fig. 34).

The clothes which one wears during the day take up the perspiration which the body throws off, and they should be aired at night while something else is worn.

One should not wear too much clothing, as it causes the body to perspire and makes the clothing wet; then when one goes to a cooler place and the air strikes one he is likely to take cold.

When exercising the air comes into the body faster and the heart beats faster than when one

rests. The clothing over these organs of breathing and circulation should then be very loose to allow them to work freely, and as the body must take many positions, the clothing should be light and should be cut in such a way as to allow the limbs plenty of freedom.

Tight bands or collars worn around the neck keep the blood from flowing freely to and from the head, and are likely to cause headache, and one cannot do clear thinking with headache.

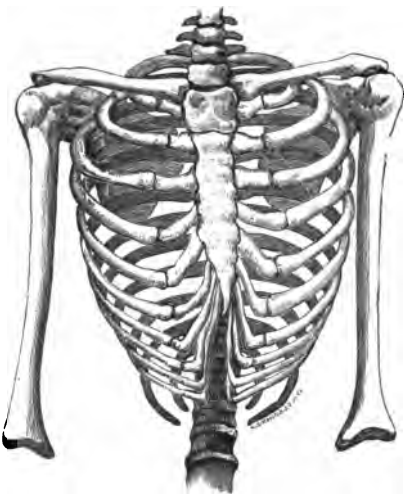


FIG. 34. — DEFORMITY OF THE RIBS.
Caused by wearing clothing tight at the waist. For the natural position of the ribs see Fig. 22.

Of course, clothes should be neat and clean, but those that cost the most are not always the ones that look the best or give the most comfort.

To be well dressed, a child should be dressed to suit his work or play, in clothing which is loose enough to allow him to get the most fun

out of his play and the most good from his study.

One should always wear enough clothing to keep from feeling cold. No part of the body can do its work so well when cold. We are less able to withstand causes of sickness when we are chilled. Whenever we go from a warm room into cold air we should have an extra wrap to throw on. If the weather suddenly turns cold when we are unprepared for it, we can resist the cold for a time by vigorous exercise until we can reach a warm room or procure warm wraps.

HOW LACK OF CLEANLINESS LEADS TO DISEASE

If we study the habits of animals, we learn that many of them give special attention to personal cleanliness. The bird takes his morning shower bath in the clear stream, and, after his breakfast of strawberry or caterpillar, he wipes off his bill as carefully as all boys and girls should brush their teeth after eating. The duck takes her swim and then spends a long time oiling and arranging her feathers. The hen prefers

a dry bath and dusts her feathers with dry earth. Pussy washes her coat with her rough tongue. The horse gives his coat a thorough rubbing down by rolling on the ground and finishes with a vigorous shake. Even the pig, it is said, would keep clean if given clean water and a clean pen.

The bees and the birds could also give some people lessons in neat housekeeping. They quickly remove all foul matter that would bring sickness into their dwellings, while around human habitations, garbage and decaying matter are sometimes allowed to lie and poison the air.

It has recently been found that flies and mosquitoes and other insects are carriers of the germs of typhoid fever, malaria, and other diseases. If we do not keep our doors and windows screened in summer, flies will come from unclean places outside into our rooms, and go directly into our sugar bowls and cream pitchers.

The mosquito comes from his cradle in the slimy bog and thrusts germs of malaria into our veins as he lances them with his bill to draw blood for his supper. Screens for our windows and doors are therefore necessary to save us doctors' bills.

In some countries fleas and rats have been found to spread the germs of a dreadful disease called the plague. Some of our common insects, it is thought, may also spread germs of disease. We must therefore keep our houses free from vermin and insects, which we can do by traps, sulphur fumes, and other means.

Carpets and woolen hangings that collect dust and attract moths are not so healthful as smooth floors that can be quickly dusted every day and dainty muslin curtains that can be easily washed when soiled.

The sunlight is a great purifier, and when we have made our clothes, our persons, and our houses as clean as soap and water and labor can make them, the sunshine will still further aid us in driving out the lurking germs of disease.

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